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**A CONTINUING MEDICAL EDUCATION
PROGRAM BASED IN HIGH QUALITY EVIDENCE
TO TRANSFER KNOWLEDGE
AND TO IMPROVE PRACTICE
FOR HEALTH CARE PROFESSIONALS**


Lorenzo P. Moja

Thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
In partial fulfilment of the requirements for the degree of

Doctor of Philosophy of Biological Sciences

Supervisor: Prof. Jeremy Grimshaw
Director of Studies: Alessandro Liberati (Deceased 1 January 2012)
Since April 2013 Prof. Carlo La Vecchia

Affiliated Research Centre Programme
IRCCS Mario Negri Institute for Pharmacological Research
The Open University, UK


The Open University, UK
— *Advanced School of Pharmacology* —
Dean, Enrico Garattini MD
**IRCCS - Mario Negri Institute for
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“These two rules, thou must have always in a readiness. First, do nothing at all, but what reason proceeding from that regal and supreme part, shall for the good and benefit of men, suggest unto thee. And secondly, if any man that is present shall be able to rectify thee or to turn thee from some erroneous persuasion, that thou be always ready to change thy mind, and this change to proceed, not from any respect of any pleasure or credit thereon depending, but always from some probable apparent ground of justice, or of some public good thereby to be furthered; or from some other such inducement.”

Marcus Aurelius, Meditations, Book IV, X.

1 Student details

Your full name: Lorenzo Moja

Personal identifier (PI): Y4898338

Affiliated Research Centre (ARC) (if applicable): Mario Negri Institute for Pharmacological Research

Department:

Thesis title: A continuing medical education program based in high quality evidence to transfer knowledge and to improve practice for health care professionals

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Abstract

This Doctoral of Philosophy program aimed to evaluate an initiative to foster knowledge translation through a national, interactive, and distant continuing education program based on an evidence-based medicine point-of-care information service. It further explored the quality of the contents used in ECCE as compared to its market competitors (i.e. other evidence-based practice point-of-care services). Our randomised controlled trial of nearly 200 physicians revealed little evidence for a difference in the health care knowledge of physicians who were exposed to versus those who were not exposed to contents derived from a point-of-care service. These results suggest that changes in behaviours, a direct consequence of changes in knowledge, may be difficult to obtain or might not be attainable at all, at least when a single continuing medical education program is implemented for short time period. In terms of determining the best available online resources among the 18 authoritative point-of-care services for guidance in clinical decision making that were assessed, only a minority satisfied the quality criteria (coverage of medical conditions, editorial quality, evidence-based methodology, and speed of updating), with none excelling in all. Publishers should continue to invest in the development of such products and improve their efficient use in continuing educational programs. These results might influence how international research and editorial groups that advocate evidence-based decision-making and evidence syntheses think about dissemination.

Scientific Summary

Problem

Cultural perception, research, and services about evidence-based medicine have evolved rapidly in the last several years, impacting the role and the architecture of continuing medical education across health care systems. Temporally, these changes have paralleled the rise of the relatively new field of knowledge translation: research that encompasses the synthesis, dissemination, and exchange of knowledge to improve health. This Doctoral of Philosophy program aimed to evaluate an initiative to foster knowledge translation through a national, interactive, and distant continuing education model (i.e. ECCE, an acronym for Continuing Education Clinical Evidence) based on an evidence-based medicine point-of-care information service (i.e. *Clinical Evidence*). It further explored the quality of the contents used in ECCE as compared to its market competitors (i.e. other evidence-based practice point-of-care services).

Methodology

To answer the first question – is ECCE as an e-learning intervention effective in improving the knowledge of health professionals? – a before and after pragmatic randomised trial utilising a two by two incomplete block design was conducted to compare the knowledge outcomes of physicians with access to ECCE versus those without access. The primary outcome was the retention of learned knowledge six months after the intervention. To answer the second question - are online evidence-based practice point-of-care summary services of good quality, “evidence-based,” and updated? – a systematic review was performed to examine English-language, online-delivered services that claimed to provide evidence-based information and were to be used at the bedside. These were assessed and ranked according to: (1) coverage (volume) of medical conditions, (2) editorial quality, (3) evidence-based methodology, and (4) speed of updating.

Results

Is ECCE as an e-learning intervention effective in improving the knowledge of health professionals? Of the 193 consenting participants, 104 completed the nine-month follow-up (53.9%). According to the available case analysis, the knowledge score, at three months, per physician in the first block improved by 5.77% for those in the intervention group; alternatively, the knowledge score decreased in the control group with a mean reduction of 5.96% ($p=0.0204$). For physicians in the second block, the knowledge score at

three months per physician was improved by 6.91% in the intervention, and by 2.00% in control ($p=0.2486$). From three to nine months of follow-up, knowledge dropped in both arms. There were no significant differences in knowledge scores at nine months ($p=0.1035$ and $p=0.1201$).

Are online evidence-based practice point-of-care services of good quality, “evidence-based,” and updated? Eighteen products met our inclusion criteria and were qualitatively described; 16 provided sufficient data for quantitative evaluation. The coverage (median 80.6%; interquartile range: 68.9-84.2%) varied for the different products. Similarly, differences emerged for “editorial policy” (median 8.0, interquartile range 5.8 – 10.3) and “evidence-based methodology” scores (median 10.0, interquartile range 1.0 – 12.8) on a 15 point scale. From a quantitative perspective, Dynamed, eMedicine, and First Consult were the most comprehensive services. The best editorial quality was delivered by Clinical Evidence (scores are shown in brackets (15)), UpToDate (15), eMedicine (13), Dynamed (11), and eTG complete (10). BestBETs, Clinical Evidence, EBM Guidelines, and UpToDate obtained the maximal score (15 points each) for the best evidence-based methodology, followed by Dynamed and Map Of Medicine (12 points each). One service’s updating process clearly surpassed the others (Dynamed versus two seconds EBM Guidelines and UpToDate: Hazard Ratio 4.96, CI 95% 3.57 to 6.88 and 5.81, CI 95% 3.96 to 8.52, both $p=0.0001$).

Conclusions

A national online continuing medical education program based on a point-of-care service and vignettes led to a modest knowledge gain compared to the control for the first three months, although the differences were not significant after nine months. Adherence of participants was poor, and the attrition high. Publishers need to continue to invest and make important contributions to the development of products that support the clinical decision making of health professionals at the point-of-care. Some services have better profiles than others and there is ample room for improvement in the transparent and complete reporting of their strengths and weaknesses. The integration of these products into continuing medical education programs should be further considered by research, publishing, and licensing and accreditation groups.

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I would like to thank the members of the Italian Cochrane Centre, the *Laboratorio per lo sviluppo di nuove strategie farmacologiche* of the IRCCS Mario Negri Institute for Pharmacological Research and the Unit of Biostatistics of the University of Modena and Reggio-Emilia for your guidance and collegiality over the past few years that have led to my completion of the program and this thesis.

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Acronyms and Abbreviations

ACCME: Accreditation Council for Continuing Medical Education

ACP: American College of Physicians

AIFA: Agenzia Italiana del Farmaco – Italian Medicines Agency

ANOVA: Analyses of Variance

CE: Clinical Evidence

CDSR: Cochrane Database of Systematic Reviews

CEPD: Continuing Professional Education and Development

CFPC: College of Family Physicians of Canada

CME: Continuing Medical Education

CPD: Continuing Professional Development

CV: Content Validity

EB: Evidence Based

EBM: Evidence Based Medicine

EBP: Evidence Based Practice

ECCE: Educazione Continua Clinical Evidence (i.e. Continuing Education Clinical Evidence (CE))

GP: General Practitioner

HR: Hazard Ratio

ICC: Italian Cochrane Centre

ICD: International Classification of Diseases

ICEKUBE: Italian Clinical Evidence Knowledge Utilization Behaviour Evaluation

ITT: Intention To Treat

KT: Knowledge Translation

KVC: Content Validity inter-rater agreement Kappa coefficient

MOL: Maintenance of Licensure

PDA: Personal Digital Assistant

PhD: Doctor of Philosophy

RCT: Randomised Controlled Trial

SDL: Self-directed Learning

SR: Systematic review

UJ: Users' Judgement

Preamble

This thesis represents the research spinoff of an educational distance program for the Italian Medicines Agency (AIFA) entitled, “ECCE – Educazione Continua Clinical Evidence” (i.e. Continuing Education Clinical Evidence (CE)) led by Prof. Alessandro Liberati¹ (Italian Cochrane Centre) and Pietro Dri (Zadig Publisher). The ECCE e-learning program was funded by the Italian Ministry of Health for the period 2005-2008. The Italian Cochrane Centre (ICC), hosted by the IRCCS Mario Negri Institute for Pharmacological Research, had the scientific responsibility for the translation and Italian adaptation of CE whereas Zadig had the editorial responsibility for the development of the e-learning modules and the ECCE platform.

The main objective of this Doctor of Philosophy (PhD) project focused on an evaluation of an initiative to foster Knowledge Translation through a national, interactive, distant, continuing education model (i.e., ECCE). Beside this objective the PhD also explored the quality of the contents (i.e. CE) used in ECCE and compared them against other market competitors (i.e. other evidence-based practice point of care services). The research questions targeted by this PhD were: a) Is ECCE as an e-learning intervention effective in improving the knowledge of health professionals? Methods: randomised control trial; b) Are online evidence-based practice point-of-care services of good quality and “evidence-based”? Methods: systematic review.

These research questions had potential practical implications for ECCE. If ECCE would not have been dismantled by the AIFA, the answers generated might have driven the further development and evolution of the program.

As a member of the CE and ECCE project team, I actively participated in all phases of the project. I contributed to the development of the editorial and educational contents, research grant submissions, project protocol development, monitoring and performance reports (supervised by Prof. Alessandro Liberati, ICC, and Pietro Dri, Zadig). For the thesis, I led the development of the RCT, including the design, the protocol development, the registration, the recruitment and the analysis of the results (with Ivan Moschetti, general practitioner, and Michela Cinquini, statistician, both involved in the project since inception). I co-led the review of the evidence-based practice point-of-care services (with

¹ Professor Alessandro Liberati died on 1 January 2012 in Bologna, Italy, from complications of multiple myeloma. He was the inspiring leader of the Italian Cochrane Centre, and a major figure within the evidence-based healthcare community.

Dr. Rita Banzi, researcher at the ICC) designing the reviews, detailing the operational definitions of the quality assessment, testing the electronic search strategies, screening the results of electronic searches, testing the extraction form for included point-of-care services, undertaking the analysis (with Michela Cinquini) and drafting the full-text of the manuscripts. Rita Banzi, Valentina Pecoraro (research assistant, ICC) and Ludovica Tagliabue (resident in Public Health, University of Milan) undertook dual independent data abstraction of all included point-of-care services.

Throughout my thesis project, I was supervised by Prof. Alessandro Liberati (ICC), and Dr. Jeremy Grimshaw (Ottawa Health Research Institute) and supported as needed by other members of the ICEKUBE project team (Rita Banzi, Sabrina Bidoli, Michela Cinquini, Luca Clivio, Anna Compagnoni, Christian Deligant, Piergiorgio Duca, Pietro Dri, Ivan Moschetti, Roberto Manfrini, Valentina Pecoraro, Roberto Satolli, Ludovica Tagliabue. Lately I have been also supervised by Prof. Carlo La Vecchia, who took over the role of Prof. Alessandro Liberati. Koren Kwag and Francesca Ruggiero supported the thesis writing, helping me in imparting a coherent and appropriate style to the thesis. Koren also was key in discussing the ideas and contents of Chapter 2.

I am responsible for all of the contents and analyses presented in this thesis.

The thesis contains six chapters. The first chapter assembles the different main aspects addressed by this thesis, providing a brief review of the literature of continuing medical education, e-learning, and point-of-care services and it serves as introduction to the other chapters. It is not intended as a publication article although some parts addressing the role and evolution of point-of-care services over the last two decades was presented in a narrative review published in 2011 in the *International Journal of Clinical Practice*. Chapter 2 is formatted as a debate analysis focused on point-of-care services that respond to the information needs of health professionals and how these tools could be foster into the CME accreditation system. It has not been published. Chapter 3 is formatted as a systematic review. It describes online point-of-care services available in 2008 and evaluates their coverage, content development, and editorial policy against their claims of being “evidence-based”. It has been published in 2010 in the *Journal of Medical Internet Research*. Chapter 4 is formatted as an evaluation study of the updating capability of evidence relevant for medical practice by international point-of-care information services. It was published in 2012 in the *British Medical Journal*. The Randomised Controlled Trial (RCT) study results are presented in Chapter 5. The protocol of this trial was published in

2008 in *Implementation Science*. The paper with final results has to be submitted to a biomedical journal. The last Chapter (#6) contextualizes the results of the RCT and ECCE experience and explores how these results contributed and added on the existing knowledge, mostly referring to an international collaborative CME program inspired by ECCE: the Dr Cochrane. It is not intended for publication. It should be noticed that I did not insert in the thesis a background chapter describing the impact of ECCE in Italy. This background information, as well all publications referring to ECCE published in English, are reported as Appendices after all Chapters. Publications in Italian are only listed but are available upon request to myself.

Chapter 1.

Introduction

1.1 Background

Despite the considerable resources devoted to health science, the transfer of research findings into clinical practice is often a slow and haphazard process. About two decades ago, evidence-based medicine has been advocated as a possible solution (Evidence-based medicine, 1992): an explicit approach to generate relevant answerable clinical questions, interpreting the available knowledge derived from controlled studies, and judging how to apply that knowledge to a specific clinical setting or a patient population.

The shift to this innovative paradigm required that all clinicians take responsibility for the transfer of research findings to their own practice. Now, this could be a problem because it is probably too much to require that ordinary clinicians become experts in knowledge translation or implementation science. To support the development of the evidence-based medicine culture two basic strategies have been adopted: information and education. These strategies might vary in their implementation depending if they target health professional students or practicing health professionals. In this thesis, we will refer to postgraduate health professionals, unless otherwise reported.

My research focussed on an intervention that integrates information and education to support evidence based practice for postgraduate health professionals. I have conceptualized continuing medical education (CME) programs based in high-quality evidence to transfer knowledge and to improve practice for health care professionals as consisting of three main components: CME, evidence-based information services at the point of care and e-learning. It is not the only way of thinking about the integration of information and education at the point of care (Casebeer et al., 2003) (Wiecha et al., 2002) (Davis et al., 1995), but it provides a pragmatic approach which might be useful in leading to direct applications of theoretical constructs of lifelong and lifewide education of health care professionals. I avoided the construct of an academic impractical framework, exploring a pragmatic research pipeline to evaluate clinical information services created for physicians and other health professionals converging their utility at the point-of-care and their potentialities as educational tools. This cross-contamination of interventions may improve the transfer of research findings into clinical practice.

1.2 Knowledge Transfer

It is widely accepted that research is a crucial investment to foster innovation, knowledge advancement, and social and economic development. For example a knowledge gain is assumed to result from biomedical and basic research (Banzi et al., 2011b). Unluckily much of the information produced is not easily transferable to patient care: even the most ambitious investments on health research will not change individual and population outcomes unless research findings are not adopted by health care professionals and health services (Grimshaw et al., 2001). In fact, despite conspicuous investments on health research, a consistent finding from the literature is that the transfer of research findings into practice is often a slow and haphazard process (Agency for Health Research and Quality, 2001). Whenever the transfer is inappropriately long, patients are denied treatments of proven benefit. Whenever the transfer is inappropriately premature, before the effectiveness of treatments have been established, patients are exposed to potentially ineffective and even harmful treatments.

There is considerable evidence of a knowledge translation (KT) gap in healthcare practice and policy. Studies internationally suggest that about 35% of patients do not receive care according to current scientific evidence, and about 25% of care provided is potentially harmful (Grol, 2001) (Schuster et al., 2005). Similar research from Italy has also identified KT gaps. Within primary care settings, under-prescription has been observed in the use of antiplatelet and beta-blockers in prevention of myocardial infarction (Filippi et al., 2006), and in the use of diuretics and angiotensin-converting-enzyme inhibitors in type II diabetic patients (Boero et al., 2003). In orthopaedics, a recent study surveyed the time from hospital admission to reparative surgery for hip fractures. Pre-operative delay varied from one region to another, increasing mortality risk (up to 4 % of absolute risk difference after adjustments) (Gini et al., 2007). This KT gap has significant adverse effects on the health of patients around the world and in Italy.

Health care systems are nowadays increasingly interested in overcoming the long and not linear translation and to facilitate a quicker return of their investment in terms of information that would help selecting the more effective interventions so that quality and appropriateness can be maximised (Agenzia sanitaria e sociale regionale dell'Emilia-Romagna, 2009) (AIFA Research & Development Working Group, 2010).

A possible solution is represented by a chain of interventions and tools, the focus of this chapter. CME, online information sources that critically appraise, synthesize, and deliver high-quality evidence in a user-friendly manner (i.e. point-of-care services) and e-learning

are possible interventions aimed at changing or supporting professional behaviour based on research evidence. These solutions can be integrated in a synergic and pragmatic approach eliciting a straightforward transfer of knowledge. One key aspect is that these interventions can be all planned at the national level, scaling up existing evidence-based mentoring programmes and providing practical advice and support on large scale health professional settings armed with a simple internet connection.

1.3 CME for health professionals

Although the concept of CME is not new, the re-validation and re-certification of medical practice enforced by law is relatively recent (Peck et al., 2000). In fact, since clinical practice begun to be an institutionalized instruction (medical instruction affiliated with medical colleges, academic and research hospitals), health professionals continued their education by formal and informal activities (Wikipedia contributors, 2013): meeting with their peers, grand rounds, case discussions and journal clubs, and scientific symposia to discuss innovative interventions and new results constituted the continuing learning experience. More recently there has been an increasing pressure from the general society to the medical community to adopt more strict rules and norms driving the continuing learning experience. This social pressure rests on a combination of factors, also including:

- 1) Evidence that a lot of science has a short shelf life: in 2007, Shojania et al. determined that 15 percent of systematic reviews went out of date within a year, 23 percent within two years, and the average review was overturned in five (Shojania et al., 2007). Updating knowledge of health professionals seems necessary.
- 2) Mechanistic evidence that forcing a learning activity will help transferring the message that learning is socially preferable to not learning and might help achieving high compliance with higher professional standards, holding physicians accountable (Merkur et al., 2008, Knowles et al., 2005).
- 3) Action research evidence that health professional education can be successfully implemented (Moja et al., 2007).
- 4) Perception that CME activities funded by the pharmaceutical industry might lead to commercial and informational bias (Pisacane, 2008).

There is no single definition of CME in the literature and this is probably due to the broadness of the construct. Lifelong learning and Continuing Professional Development (CPD) are increasingly popular alternative terms. Lifelong learning is “a continuously supportive process that stimulates and empowers individuals (physicians and other health

professionals) to acquire all the knowledge, values, skills, and understanding they will require throughout their lifetimes” and which enables the application of these skills “with confidence, creativity, and enjoyment in all roles, circumstances, and environments” (Bankey and Campbell, 2007). This definition highlights the process involved in continuously seeking, acquiring, renewing and upgrading knowledge, skills and attitudes. Another important aspect of CME is the legislative framework in which learning activities are fostered. In the last two decades many countries legislated within their health systems the re-validation and re-certification of medical practitioners. However, despite the longstanding recognition that CME is a professional commitment to sustain the quality of medical practice, regulations and contents across countries remains diverse (Horsley et al., 2010). Most require doctors to report a certain number of credits over a defined period and describe CME as compulsory, only a minority require some form of formal peer review (Peck et al., 2000). CME policies can be implemented through health professional policies (e.g. the Canadian Royal College of Physicians and Surgeons or the US Accreditation Council for Continuing Medical Education) or legislation affecting health professional at a national, state or community level (e.g. ward). The CME system only provides the legislative infrastructure in which the intervention is set-up: health professionals are free to improve their knowledge and skills irrespective of CME credits. However a regulated CME system could facilitate knowledge and skill transfer.

Some considerations and policy options can be formalised. Educational and health systems must provide an infrastructure supporting a range of activities that can be used by physicians and health teams to ameliorate their performance in practice. For CME to be effective and acceptable, physicians will require continuous learning across multiple competencies, using a variety of educational approaches, but it will also be necessary for the educational strategies to be closely linked to both clinical needs and the needs of health care systems. Physicians are expected to engage in learning opportunities that are reasonably free of commercial influence and that are learner-centred. The educational activities that are included within a national CME system should be developed to ensure that the content is of the highest academic quality and integrity, that it is balanced and that it is independent from commercial influence and market profit-making logic. While the focus is on physicians, policies should be transferable to other health professionals as well. A systematic review about the effectiveness of CME systems showed that these educational frameworks have a positive impact on professional knowledge and behaviours (e.g., appropriate prescriptions) (Marinopoulos et al., 2007). Other systematic reviews and

meta-analyses confirmed these findings although the impact and effect sizes have been variably depicted from small to moderate (Mansouri and Lockyer, 2007) (Davis and Galbraith, 2009). In another review Davis and Davis outlined different strategies of CME and CPD interventions: these include large group sessions, small group learning, distant-based learning (also referred as e- or internet-based learning) and self-directed learning (Davis and Davis, 2010). The overall characteristics of these learning programs are rapidly evolving, and the understanding of the dimensions that characterize their quality and effectiveness are still in its infancy despite the emerging consensus that such lifelong learning strategies are professionally and scientifically essential (Horsley et al., 2010).

1.4 Point-of-care information services

Even in a legislative authoritarian system, what remains crucial are the information sources that are selected and that will drive the transfer of research findings to the users at the front end. The vast majority of post-graduate education was (and probably is still) financially supported by the pharmaceutical companies (Podolsky and Greene, 2008). Although the pharmaceutical industry could play a valuable role in CME provision and support, it is important that the role of the pharmaceutical industry is counter-balanced by other independent stakeholders involved in CME promotion. In fact pharmaceutical companies support meetings about highly-prevalent diseases whereas they consider too risky or uneconomic to support education for under-represented populations (i.e. children, pregnant women, etc) and they are only partially interested in non-pharmacological interventions such as surgery, physiotherapy and psychotherapy. These interventions have their place in therapy and cannot remain unaddressed. Finally the drug companies tend to emphasize the benefits of the interventions and to suppress the unfavourable results or the adverse events (Relman, 2001) (Bero et al., 2007). These uncovered needs fuelled the generation of a parallel information systems (e.g. Clinical Evidence - BMJ Publishing Group, Clinical Knowledge Summaries - National Institute for Clinical Excellence, etc.) which started to collect data about the net benefit of all the available interventions. Being independent – not interested in the selection of positive findings – these information systems oriented themselves toward synthesis of studies and relied on summaries of the current state of knowledge (i.e. reviews of literature) about the prevention, treatment and diagnosis of clinical conditions, based on thorough searches and appraisal of the literature. Systematic reviews provide a comprehensive appraisal of evidence, being these positive, inconclusive or negative, and help the emersion of results that are within the proportion to the truth

(Ioannidis et al., 2001) (Ioannidis, 2005) (Young and Horton, 2005). Regarded as the strongest form of medical evidence, systematic reviews are gaining momentum and attracting interests from publishers and readers.

Doctors and other health professionals are increasingly aware of their information needs: they know that receiving high-quality answers as quickly as possible is a priority in their daily activity to improve the quality and efficiency of their clinical decision making (McGowan et al., 2010). For answering clinical questions doctors desire to be linked to a wide variety of information sources such as systematic reviews, evidence summaries or guidelines from government or other health agencies, major RCTs with commentary, position statements from professional organizations and excerpts from medical textbooks. High quality systematic reviews are rated more highly by physicians in terms of relevance to clinical practice than other designs of articles (McKinlay et al., 2008).

While systematic reviews have been widely available for more than two decades and continue to grow in number (Bastian et al., 2010), their relevance to health professionals at the point of care has gained increasing attention in the last ten years. The central role of systematic reviews has been magisterially addressed by the 4S model theorised by Brian Haynes: “The figure provides a ‘4S’ hierarchical structure, with original ‘studies’ at the base, ‘syntheses’ (systematic reviews) of evidence just above the base, ‘synopses’ of studies and syntheses next up, and the most evolved evidence-based information ‘systems’ at the top. Information seekers should begin looking at the highest level resource available for the problem that prompted their search” (Haynes, 2001). Systematic reviews and summaries (or syntheses or synopses) are strictly linked, being the former the unit of analysis of the second. The opportunity for publishers to create a new category of products (referred in this thesis as services) has been possible through the combination of positive trends and maturation. First, the increasing numbers of relevant studies, systematic reviews and summaries. Second, the improvement in the information technology and systems. Third, the lower cost to access better information resources. Fourth, the increased recognition by health professionals of the central role of accessing the best current evidence to support their clinical practice.

Point-of-care services link the health professional to a wide range of summarised information through the Internet. The transfer of knowledge is quick and allows the extraction of the right piece of information (i.e. micro information regarding a single patient / condition and the utility of a certain intervention) without losing information from the broader perspective (macro information regarding the whole group of patients

with that disease, the available interventions, the available diagnostic options, etc.). One of the first point-of-care services was launched in 1995 by the BMJ Publishing Group: Clinical Evidence (Godlee, 1995). It was presented as a compendium summarizing the best available evidence of the effects of health care interventions, published and updated twice a year. The key distinguishing features of Clinical Evidence (Formoso et al., 2003) were that:

- its contents were driven by practical questions rather than by the availability of research evidence;
- it aimed not to make recommendations (unlike practice guidelines) but to inform health professionals on the best available evidence;
- it highlighted rather than hide gaps in research evidence, so that physicians know when their uncertainty stems from the gaps in research evidence rather than from gaps in their own knowledge.

After the launch Clinical Evidence, other point-of-care services have been developed by medical publishers, and other governmental or non-governmental entities. In Table 1.1 I report an incomplete list of most popular point-of-care services available on the market in 2006, including details of the original publisher, the accessibility and the website. All these are in English with the exception of Clinical Evidence, which has been translated into Italian and EBM Guidelines which was available also in Finnish at that time. Point-of-care services are compared in Chapter 3. In this section I explore the reason of their diffusion and their general characteristics.

Table 1.1. An incomplete list of the most popular point-of-care services available in 2006.

Name	Publisher	Access	Website
BestBets	Department of Emergency Medicine, Manchester Royal Infirmary	Free	www.bestbets.org
CKS	NHS	Free	http://cks.library.nhs.uk/

Clinical Evidence	BMJ Publishing group	Free (Italian Edition)	www.clinev.it
Dynamed	EBSCO Publishing	Subscription fee	www.ebscohost.com/dynamed/
Emedicine	WebMD – Medscape	Free	http://emedicine.medscape.com/
EBM Guidelines	Wiley Blackwell Interscience – Duodecim	Subscription fee	http://ebmg.wiley.com/ebmg/ltk.koti
First Consult	Elsevier	Subscription fee	www.mdconsult.com/php/138754575-2/homepage
Harrison's Practice	Mc Graw Hill	Subscription fee	www.harrisonspractice.com
UpToDate	UpToDate, Inc	Subscription fee	www.uptodate.com/home/index.html
Zynx Evidence	Zynx Health Incorporated	Subscription fee	www.zynxhealth.com/

Why point of care services are becoming popular

Doctors rely on many online information sources to satisfy their information needs: from primary published evidence such as bibliographic and journal databases (e.g. Pubmed) to secondary sources such as systematic reviews and clinical practice guidelines (Haynes et al., 1995). Unluckily, the interaction between the clinician and these information sources is largely inefficient, requiring a sum of skills to refine the question and reduce the amount of irrelevant information. It is annoying that it can take several minutes to find the desired information but only a few seconds to incorporate it into the medical decision analysis.

Exploiting the opportunity to create efficient information services to support the clinical decision workflow of busy physicians, publishers have invested a remarkable amount of energy in properly orchestrating collections of high-quality online information sources that are critically appraised, synthesized, and delivered in a user-friendly manner. To sustain the added value of these innovative tools, the marketing management of some publishers claims that their use would be appropriate when clinicians and patients interact, at the point of care. The marketing suggestion is powerful: contents conveying a clear and concise

message about what to do within the context of a provider-patient dyad become worldwide popular as point-of-care services.

General characteristics

We can distinguish two families of point-of-care information services: the first simply collect and organize relevant and synthesized information sources (e.g. meta-lists, search engines); the second elaborate this information into original and structured contents (summaries, synopses). Both draw on two pillars of evidence-based information mastery: filtering and organizing. Medical literature is selected for relevance and validity (filtering) and presented in a quick, easy, accessible form (organizing).

Following Haynes' classification, these services are set at the tip of the pyramidal 6S model (DiCenso et al., 2009, Haynes, 2001, Haynes, 2006) comprehensive and sophisticated information tools (systems, summaries) built up on a systematic assembly of the evidence (synthesis, synopsis). Although Haynes gives a thorough perspective of the layer differences in his model, services may overflow between layers, may evolve from one layer to another, or peculiar elements may be attributed to more than one layer.

The innovative aspect of these information services relies on how contents are engineered to be used at the point of care. Point-of-care information can be logically grouped around common medical scenarios and translated into sets of actions – what to do – related to diagnosis, treatment and management. Two examples of how these services mime the natural thought flow for treatment and diagnosis are presented in Figures 1.1 and 1.2, respectively.

These sets of actions result in structured lists of items including a summary, definition and key therapeutic and diagnostic steps specific to the patient scenario. Software and interface are the core components of point-of-care service architecture: they should be able to naturally adapt contents to the clinical workflow (i.e. provide the first-line options, then the alternatives), minimizing the number of clicks required to reach information and providing the information in real time.

Figure 1.1. Mimic of an hypothetical thought flow targeting the treatment for acne vulgaris (adapted from BestPractice, <http://bestpractice.bmj.com/best-practice/welcome.html>)

Step 1 of 4
Search topic of interest

Step 2 of 4
Browse navigation menu

Step 3 of 4
Treatment Details

Step 4 of 4
1st line treatment

Name of the service

Find:

Search

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Browse

Acne vulgaris

Key Features	Background	Prevention	Diagnosis	Treatment	Follow up	Resources
•Summary •At a glance •...	•Definition •Epidemiology •Physiology •...	•Primary •Secondary •...	•History •Examination •Risk factor •Differential •...	•Details •Approach •Emergent •...	•Monitoring •Complications •...	•References •Calculators •Images •Patient info •...

Select your patient group

- mild-to-moderate acne: non-inflammatory
- mild-to-moderate acne: inflammatory
- moderate-to-severe hormone-related, non-nodulocystic acne
- moderate-to-severe hormone-related, non-nodulocystic acne: inflammatory
- moderate-to-severe non-hormone-related, non-nodulocystic acne: non-inflammatory
- moderate-to-severe non-hormone-related, non-nodulocystic acne: inflammatory
- severe nodulocystic acne or acne resistant to standard treatment

mild-to-moderate acne - non-inflammatory

keratolytic (topical retinoid or salicylic acid)

<<Back

•It is important that patients apply the medicine to the whole treatment area (e.g., the entire face), not to specific acne lesions.

•Topical retinoids include tretinoin [C Evidence], adapalene [B Evidence] and tazarotene.

•Most topical retinoids produce some degree of fine peeling and erythema, especially early in treatment. Patients are started with lower potency and increased [Evidence Level B]

•Salicylic acid is keratolytic, but is considered a less effective retinoids.

RCTs of <200 participants, methodologically flawed

RCTs of >200 participants, methodologically flawed

SRs or good quality observational cohort studies.

Primary Options

tretinoin topical: (0.01 to 0.1%) children >12 years of age and adults: apply to the affected area(s) once daily before bedtime or on alternate days

OR

adapalene topical: (0.1%) children >12 years of age and adults: apply to the affected area(s) every evening

OR

tazarotene topical: (0.05 to 0.1%) children >12 years of age and adults: apply to the affected area(s) every evening

less likely to cause irritation than tretinoin (ref).

More

Close X

Secondary Options

salicylic acid topical : (0.5 to 2%) consult product literature for guidance on dosage

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Figure 1.2. Mimic of an hypothetical thought flow targeting the diagnosis of obstructive sleep apnea (adapted from Dynamed, <http://www.ebscohost.com/dynamed/>)

Step 1 of 3
Search topic of interest

Name of the service

Find:

ABCDEF GHIJ KLMNOP QRSTUVWXY Z

Step 2 of 3
Browse navigation menu

Obstructive sleep apnea

General information

Causes and risk factors

Complication and associated conditions

History

Physical

Diagnosis

Prognosis

Treatment

Prevention and screening

References

Patient information

Step 3 of 3
Expand/collapse section of interest

Making the diagnosis:

-overnight full-channel polysomnography remains "gold standard" for diagnosis of sleep apnea

-history and physical alone insufficient to diagnose OSA

*based on cohort study of 101 patients presenting to otorhinolaryngologic clinic with primary complaint of snoring

*no item in history, physical or combination could distinguish obstructive sleep apnea from snoring in study

*52 patients had OSA defined as apnea-hypopnea index > 10 on polysomnography

*no differences between patients with and without OSA for septal deviation, tonsil size, low velum level, or hyperplasia of tongue base

*patients with OSA

tended to be more likely to report occurrence of apnea

had more pronounced narrowing of airway (at levels of velum and tongue base) during Muller maneuver (patient attempts inspiration with mouth closed and nostrils clamped shut while being observed with fiberoptic scope looking for collapse of upper airway)

-Rule out:

-central sleep apnea

-airway obstruction, including tumor

-other causes of disrupted sleep, such as restless legs syndrome or periodic limb movements

-nocturnal seizures

-simple snoring may result in daytime sleepiness without OSA

Testing to consider

* sleep study with polysomnography

* nocturnal pulse oximetry may be simpler alternative

o high positive predictive value if abnormal in patients without obstructive lung disease

o negative (normal) pulse oximetry not sufficient to rule out OSA

* blood tests to consider

o elevated hemoglobin or hematocrit suggests chronic hypoxia

o glucose (OSA associated with diabetes and glucose intolerance)

o thyroid-stimulating hormone (TSH) (hypothyroidism may contribute to upper airway obstruction and OSA)

* electrocardiogram (ECG) (possible association of OSA with atrial fibrillation and bradyarrhythmia)

The quality of point-of-care services indeed depends on two broad dimensions: accessibility and value of information (Ely et al., 2005). Ideally, these information resources should excel in both dimensions.

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If the consultation of online point-of-care services is a self-directed informing exercise to address knowledge needs generated during routine practice, these activities could also be seen as a learning exercise. When the learning contents are transferred through interactive online systems, this is referred as e-learning. This is the last dimension I cover in this introduction. In fact my thesis encompasses three broad dimensions: information (i.e. point-of-care services), education (i.e. e-learning and CME) and policy (i.e. again CME). When these dimensions are placed on a continuum they might become a complex intervention to improve health care practice.

1.5 E-learning

E-Learning is a broad concept that deals with the transfer and usage of knowledge, educational programmes within interactive electronic systems. Currently there is no standardised definition for research purposes and the Medical Subjects Headings Thesaurus does not provide a specific entry and definition. While researchers try to reach a consensus on the definition of this concept, the community and network for e-Learning professionals defined e-Learning as *“the use of technology to deliver instructional content and mediate learning activities. May include electronic performance support and knowledge management features”*. Aside these terms and definitions, many different terms are used in common language to refer to e-learning: web-based learning, online learning, computer-assisted or program-assisted instruction, and Internet-based learning (Cook et al., 2008) (Ruiz et al., 2006). These terms mainly differ because they emphasize a specific part of the concept, such as the media tools (i.e. computer-assisted instruction) or the delivery system (i.e. online learning). In many contexts, these definitions are interchangeable as they all refer to “digital” and “via Internet” knowledge facilitation. Although the term “e-learning” has sometimes been used to define a mixed approach alternating electronic sessions to face-to-face teaching (i.e. blended interventions), it is generally seen as a particular evolution of distance education. When learners are computer-assisted, interconnected through computer networks and they access stand-alone multimedia packages for learning, distance education can be unequivocally referred to e-learning (Ruiz et al., 2006) (Ward et al., 2001).

Traditional knowledge transfer methods are face-to-face courses using non-interactive educational materials. E-learning is gaining popularity and rapidly increasing in number. The low cost, high flexibility, and lower dependency on geographical or site boundaries are attracting the investments of stakeholders (e.g. countries, networks and universities)

and increasing the demands of learners. The delivery advantages can be easily recognized in an e-learning program: widespread distribution, increased accessibility to information, frequent content updates, personalized instruction in terms of content, and pace of learning are some of the most cited characteristics of e-learning (Wentling TL et al., 2000). Applying the latest information technologies to education takes advantage of the increasing availability of Internet access (using fiber optics, Wi-Fi and 3G cell phone technology), allowing a broad use of contents across different settings (home, workplaces, public places such as libraries, parks and Internet cafes). In addition, we are currently experiencing an important progression of Internet usage with the diffusion of websites and software which are based on collaboration among users and shared information. O'Reilly first referred to these technologies using the term Web 2.0 describing an "architecture of participation where collective intelligence generates a network effect" (O'Reilly, 2005). Podcasts, wikis, blogs and social networks are among the most popular Web 2.0 systems. For example, podcasting allows the transition from e-learning to m-learning (mobile learning) which inherits advantages from e-learning, but extends its reach by making use of portable (handheld) supports. The use of smart phone, personal digital assistant (PDA), MP3 player, and pocket PC technologies makes it easier for learners to study when and where they want by making it simple for them to transport their learning materials, facilitating "just-in-time" learning (Evans, 2008).

In 2008 Cook et al. published a quantitative meta-analysis including 201 published studies on Internet-based learning (Cook et al., 2008). Cook et al. considered three relevant outcomes: knowledge, skills and patient outcomes. The first comparison focused on e-learning and no intervention; the second on e-learning and other types of educational activities (e.g. meetings or residential learning in class). Results in terms of knowledge gain are reported in Figure 1.3 and 1.4, respectively. In the first comparison, significant differences favouring e-learning were observed for all outcomes. These differences were also relevant in terms of magnitude of the effect size. In other terms the gain in knowledge obtained by the health professionals that received the e-learning was relevant compared to the group that received no intervention. In the second comparison, the significance was formally maintained for knowledge although the effect size was reduced. There was a direction effect for skills and patient outcomes. Knowledge measurement through standardized tests is the most straight to consider for both traditional and e-learning systems. An individual progresses through cognitive and behavioural steps, from acquiring knowledge to performing a task in practice. This process is neither linear nor simple. E-

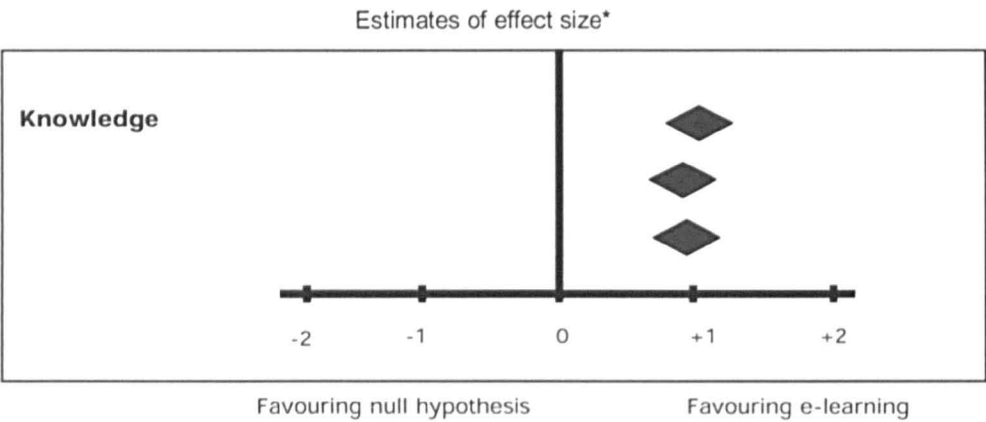
learning might directly affect only the knowledge and, with decreasing impact, the ability to apply concepts and skills in the workplace and patient outcomes (Moja et al., 2008). This does not mean that the e-learning does not have an impact on health professional behaviours or patient outcomes: the target outcome is less directly influenced by the educational intervention. The behaviours may be unchanged irrespective of a modification in the knowledge obtained through an e-learning program, because of moderators such as the inertia of the previous behaviour or organizational conditions. Many externalities influence on a doctor's performance, including system related factors (resources and government incentives, accreditation schemes) and individual-related ones (attitude toward the use of evidence, patient's expectation, relationship with peers) (Rethans et al., 2002). More we move from knowledge to health outcomes, the more the effect of the intervention is diluted.

Although Cook and colleagues conducted a comprehensive and rigorous systematic review (Cook et al., 2008), neither methodological accuracy nor the broad inclusion criteria can overcome the weakness of the primary research included in their analysis: more than half of the studies were uncontrolled before-and-after designs. Concerns arise from the novelty effect, sometimes referred to as the Hawthorne effect (Shadish et al., 2002). Positive attention effects caused by participants' involvement in an active and modern educational program and the awareness of being observed, as well as negative effects caused by being allocated to a non intervention rather than an intervention group, are non specific confounders that could introduce substantial bias in the cumulative estimates. It seems likely that these effects contributed to the positive Internet based learning effects compared with no intervention. As the causal relationship between Internet based education and favourable learning outcomes could have been biased, the conclusion made by Cook et al. of a limited value for further research comparing Internet based learning versus no intervention could have been more softer and cautious (Banzi et al., 2009).

In this context, generalizing from the findings of primary research to everyday routine is also problematic. We have a limited understanding of the characteristics of the targeted knowledge, professionals, and settings that might influence the effectiveness of different e-learning programs. Thus, for those working in the e-learning setting, the findings from this meta-analysis provide little information to guide the choice or optimize the components of such complex educational interventions. The effectiveness of e-learning is likely to be modified by characteristics such as the attitudes of the healthcare professionals or their perceived ability to transform passive information into tangible actions. The interpretation

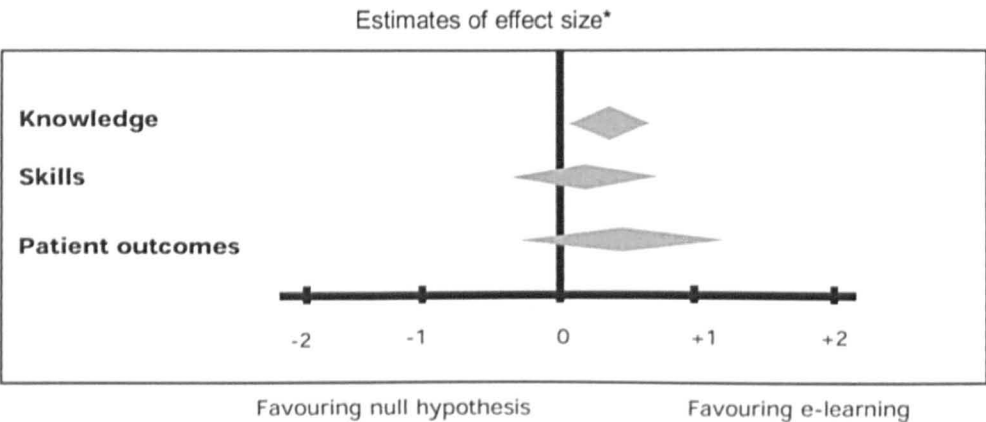
of positive or negative effects should be supported by an explicit theoretical rational and model (Eccles et al., 2005). Theories are commonly used in clinical medicine to understand and organize basic and clinical sciences. They have been also successfully used in advancing the findings derived from evidence synthesis. The results of two Cochrane reviews were re-analysed (Gardner et al., 2010, Hysong, 2009). The control theory (Carver and Scheier, 1982) and the feedback intervention theory (DeNisi and Kluger, 1996) were key in disentangling the characteristics of more effective interventions, namely explicit goals and an action plan (Ivers et al., 2014). These and other theories should be applied to additional interventions as well. However implementation researchers rarely provide an explicit theoretical rationale for their intervention (Davies et al., 2003), and even more rarely provide this at the protocol stage of research.

Figure 1.3. E-learning versus no-intervention. Adapted from Cook et al. (Cook et al., 2008)



**Heterogeneity test I^2 always greater than 85% in all meta-analyses.*

Figure 1.4. E-learning versus other educational interventions. Adapted from Cook et al. (Cook et al., 2008)



**Heterogeneity test I^2 always greater than 85% in all meta-analyses.*

1.6 Framing the research objective

E-learning professional systems are rapidly gaining momentum in several countries (e.g., USA, UK and Italy), and offer now many specialty modules in their portfolios (Coppus et al., 2007) (Moja et al., 2007) (Ruiz et al., 2007). There are few studies, which evaluated the quality of e-learning programs disseminated at the national level in the context of CME policies. This evaluation regards the quality of the contents, which must remain the basis of all of our research actions, and its effectiveness in influencing the competency of the target

audience. The results and conclusions derived from these studies might orient the information and educational systems for post-graduate health professionals in Italy and other countries as well. They can improve the contents and sources (e.g., one point-of-care product is superior to another), the relative efficacy of e-learning in the short and medium term (e.g. if improvement in knowledge is sustained over time or not) and if this multifaceted intervention (CME, point-of-care service and e-learning) can be applied to other contexts or populations.

Few national CME programs combine all these features. In Italy to maximize the effectiveness of the financial commitment for disseminating point-of-care information services, and speed up the diffusion of evidence-based medicine, the Italian Medicines Agency (AIFA) sponsored a free-access e-learning system, based on evidence-based contents, called ECCE (the Italian acronym for Continuing Education Clinical Evidence). ECCE is based on Clinical Evidence, a point –of-care service published by the BMJ Group, which comprises an international database of high-quality, rigorously developed systematic overviews assessing the benefits and harms of interventions. ECCE became accessible to all health professionals in March 2005 after a pilot period (Moja et al., 2008). As of April 3rd 2008, 35.000 doctors and 92.000 nurses voluntarily subscribed to ECCE (respectively 14% and 27% of all practicing physicians and nurses). Altogether, 228 clinical vignettes have been posted on line, 1.852.650 vignettes have been completed and 1.867.416 credits awarded. Among doctors the average number of completed vignettes for a single user was 13.75, with a corresponding average credit of 16.22. At the end of each vignette health professionals were asked —using an online questionnaire— to provide comments about their experience solving ECCE's cases (75.1% response rate). ECCE's vignettes were well received: more than 90% of users considered them relevant and appropriate for educational purposes. More than 80% expressed their intention to apply the acquired information into clinical practice. These results have been welcomed as a large success (Moja et al., 2008).

Pilot study

The large number of subscribers to ECCE suggested that this CME programme satisfied an educational need. Whether ECCE had any effect on doctors' knowledge and competency is a compelling question that was addressed through the subsequent RCT. Before embarking on this project, however, we first explored questions on the design and conduct of the full-scale trial. The pilot study was performed separately from the following full-scale trial, and

had three main objectives: 1) to explore doctors' willingness to participate in an educational trial; 2) to assess the degree of knowledge change associated with vignettes; and, 3) to persuade the funder that a full-scale trial is feasible and should be conducted.

We assessed the vignettes by looking for evidence on the responsiveness of the intervention, which refers to the measurable ability of the vignette to induce a change of the physician's knowledge, once the participant accesses the contents of Clinical Evidence. We evaluated the responsiveness using an approach similar to a before and after uncontrolled study. Before doctors accessed to vignettes and answered clinical questions but the access to Clinical Evidence was inhibited; after doctors answered the same questions, but they were instructed to read Clinical Evidence in advance. Doctors were free to choose two out of ten vignettes. Eligible doctors were naïve to ECCE. To decrease the test-retest effect, doctors were prevented to repeat the exercise for one week after completing the first test.

Between November 2006 and January 2007, 210 doctors voluntarily participated in the pilot. Ninety-eight (47%) completed both tests. The intervention was associated with a statistically significant gain in knowledge (t-test for paired data) for ten vignettes with one exception. The average gain in knowledge was 28% (95% CIs 18% to 38%), which corresponded to a standardized mean difference of 1.12 (95% CIs 0.56% to 1.68%).

The data from this pilot study were interpreted as follow.

There were limited barriers preventing doctors' participation in the educational study were limited. In fact, we were able to enrol more than two hundreds doctors over just three months.

The intervention was associated with a consistent gain in knowledge. The fact that the magnitude of this gain was large, exceeding one standard deviation, was also incorporated into the full-scale trial. The effects of one or more standard deviations could be detected with a sample size of only a few dozen people. However, since the vignettes and population of study may have been representative such that the results from the pilot study may not reflect the "true" effect of the intervention, we revised the magnitude of the effect to make it more conservative.

When we presented these results, the funder agreed with the feasibility of a trial. However the attrition was high: more than 50% of doctors who agreed to take part in the pilot did not complete the exercise. Neither the trialists nor the funder paid sufficient attention to this event that would have biased the results if replicated during the following trial. The same attrition was observed in the full-scale trial. Those who read, interpret, and use the

pilot reports should take into consideration both its feasibility and likelihood of bias. In other words, the results from the pilot study may anticipate the presence of bias associated with the intervention; these issues should be carefully explored to take full advantage of piloting a trial.

The success of ECCE as educational program was brief. After the sudden fall of the Prodi II Cabinet on January 2008, the break-up of The Union coalition and the subsequent political crisis, Berlusconi won the general election on April 2008 against Walter Veltroni's centre-left coalition in both houses of the Italian Parliament. At the end of 2008, the Berlusconi's conservative government decided to immediately suspend the funds that supported this project (AIFA (Agenzia Italiana del Farmaco), 2008). While funding stopped, the results of the research linked to this project have been completed and are reported in this thesis.

Chapter 2.

Responding to the information and education needs of health professionals: channelling point-of-care information services into CME activities

2.1 Summary

The structure and aim of continuing medical education (CME) is shifting from the passive transmission of standardized knowledge (e.g. scientific meetings) towards a self-directed learning model that is better integrated with professional practice. Point-of-care information services are innovative tools that provide health professionals with digested evidence at the frontline to guide decision-making. This chapter introduces some practical ideas about how point-of-care services and CME accreditation entities may beneficially integrate their respective activities through an innovative framework. This collaboration elicits several advantages for users, including: the transport of CME activities to the site of clinical practice to reinforce learning; ability to select the content, pace, and setting of learning; opportunity to link observations and questions from clinical practice with CME activities to increase relevant knowledge and skills; and, ultimately, gain information that matters. The author discusses potential strategies point-of-care services and CME entities can adopt to facilitate and sustain the transition to this integrated model.

2.2 Introduction

The medical community supports continuing medical education (CME) as a key intervention for the advancement of knowledge, development of new skills and capabilities, and, ultimately, the improvement of the health of patients. For physicians across many countries, CME activities are mandatory for the maintenance of certification or renewal of licenses by professional associations. Formal accreditation systems are becoming vaster on an international scale. First adopted by the United States and Europe (Horsley et al., 2010, Accreditation Council for Continuing Medical Education., 2012), the internationalization of CME activities is likely to expand into other geographical areas as well, with cross-contamination between one country and another.

Increasing research, however, contests the effectiveness of current CME programs to accomplish the above-stated goals, particularly, their ability to enhance physicians'

capabilities or improve the quality of health care. Traditional medical education consists of large audience residential meetings, small-group workshops, or printed materials. Systematic reviews consistently report modest effects of these CME activities on health professionals' knowledge and practice, irrespective of the level of participation or amount of resources vested in the CME program (Davis et al., 1999, Forsetlund et al., 2009). Referred to as e-learning, education activities using innovative technologies, while highly valued for their lower costs and increased user access, report modest effects parallel to that of traditional CME programs according to a recent meta-analysis of more than 200 studies (Cook et al., 2008). These findings call for an evolution of CME activities and their formats, namely, the development of an innovative model that promotes self-directed learning (SDL) on topics that address the knowledge needs generated during routine practice while encouraging the more active participation of health professionals. This chapter introduces some practical ideas about how point-of-care services and CME accreditation entities may beneficially integrate their respective activities through an innovative framework, representing the transition from knowledge-based to competency-based CME models.

2.3 The transition from transmission of knowledge to its application

The limits of education based on imparting knowledge has been addressed by educational methodologies and their underlying pedagogies of learning. In his theory of *andragogy*, Knowles proposes that adults must know the reason for learning something before engaging in the learning process: adults are motivated to learn only to the extent that they perceive the knowledge to assist in the performance of tasks confronted in their life situations (Knowles, 1984). Knowles further premises adults as self-directed learners.

The concept of SDL, although long existing, has gained heightened attention in the last decades with the momentum for CME reform. SDL represents the ability to take control of the mechanics and techniques of teaching oneself a particular subject (Knowles et al., 2005). The individual initiates the learning process, defines the goals and purposes of learning, and selects the strategies to undertake it. The inherent value of SDL is: i) its capacity to tailor education and the learning process to meet health professionals' individual needs; and ii) the application of knowledge gained from the learning process to accomplish specific tasks. Evidence supports SDL as one of the most effective approaches to improve knowledge (Murad et al., 2010).

2.4 Embedding SDL at the point of care: a challenge

Education should not be viewed as separate, but an integral component of patient care. Clinical practice regularly produces new questions and challenges: on average, clinicians generate at least one question per patient visit, many of which remain unanswered despite physicians' perception of the literature as a beneficial and relevant source of answers for patient care (Smith, 1996, Ebell and Shaughnessy, 2003). Questions that arise from patient care contextualizes learning, serving as a potential trigger for the SDL process. Most of such questions can be answered, but accessing and locating the right information can be time-consuming and expensive. If these triggers are not adequately channelled to locate the right information, the opportunity to improve knowledge and adopt best practice strategies is missed. The interaction between the clinician and information sources, such as bibliographic and journal databases (e.g. PubMed), should be facilitated at the point-of-care. In 2001, the Institute of Medicine expressed that a service is needed to align health professionals with current best practices through information technology (Institute of Medicine Committee on Quality of Health Care in America, 2001).

2.5 Point-of-care services to meet health professional needs

Today, busy clinicians have access not only to Medline, but to many online information solutions that are now faster, have a broader and deeper reach into the plethora of medical literature, and can quickly provide current information directly related to their everyday practices (Banzi et al., 2010). These online information sources, supported by advances in technology, including real-time information systems and portable electronic devices, can better meet the information needs arising when patients and practitioners interact compared to traditional information sources such as textbooks (Moja and Banzi, 2010). These web based compendiums are commonly referred as point-of-care information services (or summaries) and are developed and marketed by major medical publishers. They vary widely in their quality of content development and capacity to update and grade evidence (Banzi et al., 2011a, Banzi et al., 2010, Shurtz and Foster, 2011). When selecting the service to adopt in their practice, clinicians need to weigh the strengths and weaknesses of various characteristics (e.g. speed of updating) to inform their choice. On the market, the number of high-quality services is increasing. It is our impression that the use of these services is becoming common, although we were unable to locate any data about their cumulative diffusion. For instance, one service reports that more than 700,000 clinicians across 158 countries have access to it (UpToDate., 2013). In Finland and Belgium, there is

a national provision of one point-of-care service for all health care professionals (Van de Velde et al., 2013). Innovative strategies that take advantage of this widespread use can be developed to better link the information needs of community-based physicians to CME activities.

2.6 Strengthening point-of-care services for CME

The advent of point-of-care services and e-learning provides new platforms for the development of CME programs that integrate SDL with just-in-time education, which can channel experiences and questions from clinical practice to inform physicians' information needs and change their clinical behaviour. We, therefore, suggest that the use of point-of-care services should be embedded in CME programs. This can be accomplished through the following actions that are not resource-intensive and can be implemented relatively easily.

Credits where credit is due

Doctors and health professionals should earn CME credits while searching through point-of-care services. The search for evidence, its filtration, and application towards a clinical case are activities that should be recognised as CME activities. When health professionals modify their advice or behaviours based on evidence derived from randomized controlled trials and systematic reviews, they are not only seeking an evidence-based answer that could be beneficial to the patient, but are also improving their information mastery. In this context, information mastery represents the skills required to obtain the desired information as well as the ability to successfully and efficiently transfer the information to the patient. Publishers and accreditation entities need to coordinate their activities such that point-of-care services can easily track, record, and communicate the searches made by professionals to the licensing and accreditation bodies so as to issue the earned credit.

In addition to the recognition of point-of-care searches as a type of CME activity itself, CME accreditors need to further support the maturation of point-of-care publishers as CME providers. The accreditation process is becoming increasingly challenging: CME stakeholders are required to produce huge amounts of information to fulfil the expectations of licensing and accreditation bodies. The content areas addressed by the CME program; target audience; types of activities; expected results in terms of changes in knowledge, competence, or patient outcomes at the completion of the program; activity formats; and commercial support represent only a fraction of the overall requirements by licensing and

accreditation bodies. Currently, it is easier for a drug company sponsored residential event to fulfil the mandated requirements of CME licensing bodies. Compliance with standardized requirements by CME activities related to point-of-care services is more difficult, especially as the outcome of these activities is often unpredictable. Although we cannot exactly predict who will use the contents, how the content will be implemented, and for which patient, the potential impact of such activities is arguably greater than that of commercially-sponsored meetings. Licensing and accreditation bodies need to recognise the distinct characteristics of point-of-care services, drafting new requirements addressing the quality of point-of-care contents.

Valuing the impact of the information

Few accreditation entities have already recognized the importance of point-of-care services and searches as CME activities. For instance, the College of Family Physicians of Canada (CFPC) issues for up to 0.5 CFPC credits for each search submitted. However, the educational value of using point-of-care services might still be undermined. The value of a credit is usually the combination of three dimensions: its absolute value (e.g. 0.5 or 1 credit), its formal recognition (e.g. category 1 – formal, or 2 – informal, in the American Medical Association Physician’s Recognition Award system), and their relative value compared to others educational activities (e.g. the activity is limited to minimal and maximal amounts compared to others). Again, the passive participation in a scientific meeting might provide more credits than locating essential information that matters to the patient at a crucial time. We urge accreditation entities to: sustain the transition of traditional CME to a competency-based framework that facilitates SDL; favour physicians’ ongoing commitment to engage in information mastery that ensures the best payback for patients at the point-of-care; and limit policies (i.e. ‘one size fits all’) that allocate the value of CME activities based on the time spent. Rather, accreditors should evaluate CME activities based on the utility of the information – the impact it might have on patients. This policy will address the problems of overwhelming irrelevant information (i.e. the information paradox) (Smith, 2002).

Education “on-demand” and electronic health records

Publishers which develop point-of-care services should continue to invest in maturing their services for educational purposes. The use of “just-in-time” (i.e. solving a doubt about the clinical management of a patient that a doctor can apply to that patient in real time) can be

boosted by an “on-demand” teaching approach (i.e. the doctor chooses between different clinical scenarios that he or she might face in future practice and explores the relevant evidence to solve the case) (Grandage et al., 2002, Hurwitz and Slawson, 2010). Clinical vignettes serve this role, providing users with the opportunity to understand the clinical applicability of evidence and transforming point-of-care evidence into a more interactive learning experience (Peabody et al., 2004, Moja, 2010b). Publishers should update users on the addition of new contents and applications to services to maximize their use and potential payback. Publishers that provide only one stand-alone service (e.g. information), regardless of its quality, might be perceived as static and remote from practice. The information needs of health professionals will be better satisfied through information hubs in which evidence are rearranged to serve different purposes. The key aggregation point is likely to be the electronic health record. In addition to the clinical information of the patient, the doctor will have direct access to: reminders and guide messages derived from point-of-care services, which are activated by computerized decision support systems; the latest evidence from scientific journals and societies; and structured practice audits and performance metrics. The interaction of all these components will constitute the core of modern CME activities and will align the maintenance of certification to best practice uptake (Shojania et al., 2012). If this interaction fails due to the prevailing interests of one component over the others, resulting in the maintenance of separate services that serve narrow, albeit valuable, needs, health professionals will waste time and efforts to overcome additional micro-legal and organisational requirements that are not implemented in their clinical workflow (Estrin and Sim, 2010). We recognise that this step requires further resource and infrastructure investments by publishers as well as licensing, accreditation, and health policy entities; however, this proposal is advantageous in that it will increase the overall efficiency of physicians’ regular routines, emphasizing education, information, and quality improvement as an integrated and iterative process.

2.7 Conclusions

Licensing bodies and medical societies have already begun to shift from the traditional standards of CME towards competency-based medical education in which physicians must prove ongoing competence and performance as a result of participation in CME activities. In 2010, the Federation of State Medical Boards in the United States adopted the Maintenance of Licensure (i.e. MOL) framework by which state medical and osteopathic boards can require physicians with active medical licenses to demonstrate continued

clinical competence to obtain license renewal (Chaudhry, 2010). Since 2004, the Federation of Medical Regulatory Authorities of Canada announced that all licensed physicians must undergo a recognized revalidation process, demonstrating commitment to continued competence and performance as a part of professional self-regulation (Federation of Medical Regulatory Authorities of Canada Revalidation Working Group (FMRAC), 2007). Similar revalidation programs are being implemented internationally in the UK, Ireland, Australia, and New Zealand.

Licensing entities, medical societies, and publishers need to support this shift towards competency-based CME programs, providing physicians with functional opportunities and additional incentives. A question derived from a patient visit represents an opportunity for competency-based education. To encourage the active seeking of evidence that matters at the point-of-care, better credit compensation for these efforts should be awarded. The electronic health record should be seen as an aggregation point in professional development, a space in which physicians can continuously transfer questions and observations gained from clinical practice, and obtain answers to mature their expertise. These changes would meet the growing needs for competency-based CME reform to optimize patient outcomes and sustain a proficient health care professional workforce.

Chapter 3.

Online evidence-based practice point-of-care information services: how good are they?

3.1 Summary

Background

Busy clinicians need easy access to evidence-based information to inform their clinical practice. Publishers and organisations have designed specific tools to meet doctors' need at the "point of care".

Objective

This study is aimed to describe online point-of-care information services and evaluate their content development and editorial policy against their claims of being "evidence-based".

Methods

We searched MedLine, Google, librarian association websites, and information conference proceedings from January to December 2008. We included English web-based point-of-care summaries designed to deliver pre-digested, rapidly accessible, comprehensive, periodically up-dated, evidence-based information to clinicians. Two investigators independently extracted data on the general characteristics and content presentation of summaries. We assessed and ranked point- of-care products according to: a) coverage (volume) of medical conditions , b) editorial quality, c) evidence-based methodology. We explored how these factors were associated.

Results

We retrieved 30 eligible information services. Eighteen products met our inclusion criteria and were qualitatively described; 16 provided sufficient data for quantitative evaluation. The coverage (median 80.6%; interquartile range: 68.9-84.2%) varied for the different products. Similarly, differences emerged for "editorial policy" (median 8.0, interquartile range 5.8 – 10.3) and "evidence-based methodology" scores (median 10.0, interquartile range 1.0 – 12.8) on a 15 point scale. None of these dimensions turned out to be significantly associated.

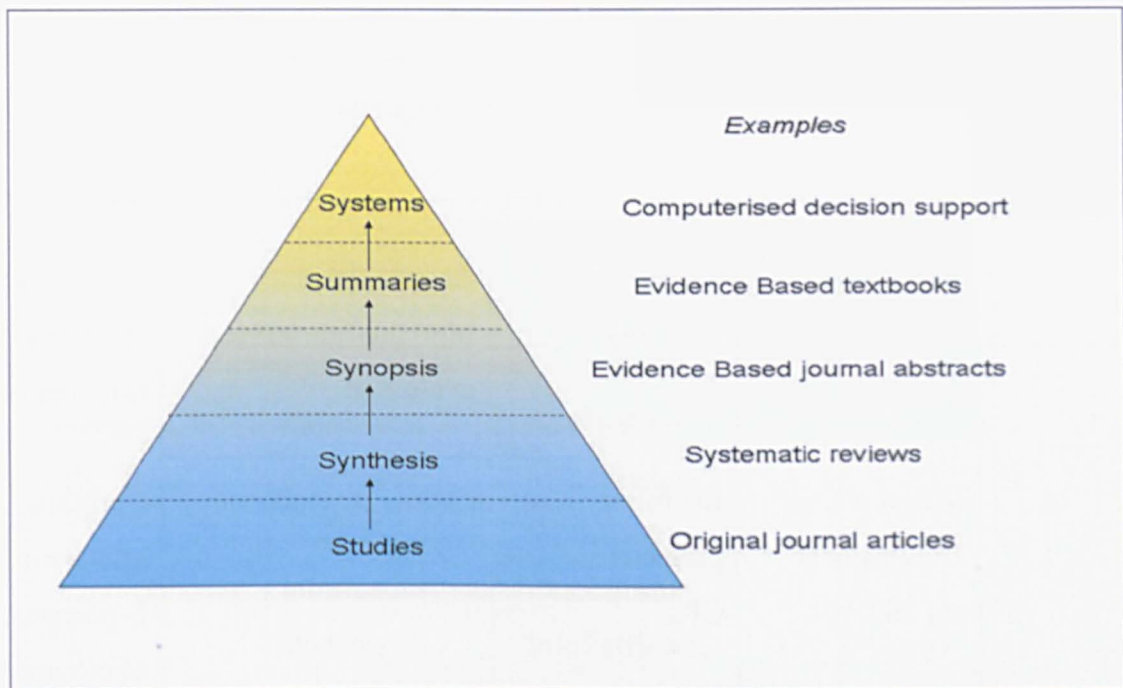
Doctors have access to many different point-of-care information services to support their clinical practice. Some have better profiles than others and there is ample room for improvement in reporting fully and transparently strengths and weaknesses of the summaries.

3.2 Introduction

In 1996 Richard Smith sought to identify the main characteristics medical information sources should have to guide doctors in their practice in the next decade. These tools should be able to answer complex questions, be connected to a large, valid database and be electronic (Smith, 1996, Tonks and Smith, 1996). Besides Medline, busy clinicians now have access to many online information solutions which are faster, have a broader and deeper reach into the plethora of medical literature, and can quickly provide current information directly related to their everyday practice from the prime medical literature and leading physicians in the field. This approach, supported by advances in the technical areas of powerful real-time information systems, fits well with medical information consumed when patients and practitioners interact, the so-called “point of care”, which has different features from traditional scholarly content (Ebell and Shaughnessy, 2003).

The unquestionable advantage of online point-of-care information services (also referred as point-of-care summaries) is to select and summarise research findings and to provide friendly interfaces aimed at improving the retrieval, synthesis, organisation, and application of this information (Ebell, 2003). The model within evidence-based practice (EBP) information summaries was first described is the “4S” paradigm (now evolved in the “5S”) which can be considered a guide for using the most “evolved” information services when searching for the best current evidence (Haynes, 2001, Haynes, 2006). Those seeking information should begin looking at the highest-level resource available, such as comprehensive and sophisticated information tools (systems, summaries); systematic assembly of the evidence (synthesis, synopsis) and individual studies should only be searched when there is no evidence-based information system for a clinical problem (Figure 3.1, (Haynes, 2001, Haynes, 2006)).

Figure 3.1. The “5S” levels of organisation of evidence from healthcare research
(adapted from Haynes model) (Haynes, 2006)



Most online services are promoted as “evidence-based” (Alper et al., 2004), implying that their contents are developed through a periodic and systematic search and critical evaluation of medical literature. “The most authoritative and accessible point of care medical reference available to physicians and other health care professionals on the Internet” is just one example of the emphatic marketing claims used for product advertising (eMedicine, 2009). However, criteria for selecting clinically important evidence are not always explicit, raising questions about the quality of information (Haynes et al., 1995). As on-line EBP point-of-care services are mushrooming and a substantial a priori trust by clinicians is to be expected, it is of prime importance to assess their quality.

Few articles comparing point-of-care services have been published. Most were aimed at assessing the user’s satisfaction and how well different online information services answered questions arising in daily clinical work (Table 3.1.) (Ely et al., 2005, Ely et al., 1999, Alper et al., 2001, D’Alessandro et al., 2004, Campbell and Ash, 2006, McCord et al., 2007, McKibbin and Fridsma, 2006, Graber et al., 1999). Keeping in mind that any user-centred evaluation to identify the best product can be biased by previous beliefs and habits of a specific service, nevertheless some services, such as UpToDate, were often ranked high. A mixture of general and medical search engines (e.g. AltaVista, WebDoctor,

MedLine), meta-lists (MD Consult, STAT!Ref), secondary literature (e.g. The Cochrane Library) and point-of-care services (e.g. Micromedex, UpToDate, Clinical Evidence, Dynamed) was compared.

Table 3.1. Studies evaluating online information services’ ability to answer clinical questions

Reference	Physicians’ specialty	Electronic information services evaluated	Best-ranked electronic information services
(Ely et al., 1999) (Ely et al., 2005)	Internists, paediatricians, GPs	Choose by clinicians	UptoDate, MDConsult, E-pocrates, Micromedex
(Graber et al., 1999)	GPs	MDConsult, HotBot, Excite, Hardin MD, Medical World Search, AltaVista, HON, Yahoo/health, Medscape, WebCrawler, Achoo, WebDoctor, Medical Matrix, Medguide, Sixsenses, MedWeb, Sleuth, MD Gateway, Medaccess	MDConsult
(Alper et al., 2001)	GPs	MDConsult, Dynamed, MAXX, MDChoice.com,	STAT!Ref, MD Consult

		American Family Physician, SUM search, Medical Metrix, Primary Care Clinical Practice Guidelines, Medscape, WebDoctor, Virtual Hospital, ClinWeb, TRIP)	
(Campbell and Ash, 2006)	Physicians, pharmacists, medical informatics students	ACP's PIER, Micromedex-Diseasedex, FirstConsult, InfoRetriever, UpToDate	UpToDate
(D'Alessandro et al., 2004)	Paediatricians	GeneralPediatrics.com, MDConsult, Medline, Micromedex	GeneralPediatrics.com, MDConsult,
(McKibbin and Fridsma, 2006)	GPs	Medline, Internet, Cochrane Database of Systematic Reviews, MD Consult, Ovid Evidence Based Medicine Reviews, UpToDate, InfoPOEMs, Lancet, Clinical Evidence	None
(McCord et al., 2007)	Family medicine residents	ePocrates, Griffith's 5-Minute Clinical Consult, UpToDate	UpToDate

Asking doctors to rate these information services, with different aims achieved through different information and technological solutions, is clearly deceptive. Systematic reviews are an immediate example of this limitation: although Cochrane reviews are long, technical and sometimes hard to read, summaries, services, systems, and other downstream products are largely based on them. In other words, systematic reviews should be viewed as evidence sources that feed point-of-care services rather than point-of-care services themselves. The results from these studies should be analysed with caution. An inappropriate comparison influences the apparent effectiveness of point-of-care services, but also satisfaction and practical details such as time for successful task realisation. Even seemingly straightforward information services have inherent complexities that can bedevil well-designed comparative research.

Beside user, or experience/satisfaction evaluation, research has looked into content-centred evaluation. The pioneering study by Wyatt et Al. offered a wide view on the quality of a variety of computer-based evidence services used by oncologists (Wyatt and Vincent, 1999). Authors suggested quality dimensions that can be vital for preferring one online information service over another: what kind of information is included, update frequency, editorial space, and how information is identified and assembled.

The objective of this chapter is to describe online EBP point-of-care services and to evaluate their content and editorial policy against their claims as “evidence-based”. As for all research, the quality of point-of-care products needs to be evaluated to ensure their real usefulness for clinical practitioners. We postulated that coverage of medical knowledge, editorial policy and content quality (three desirable criteria) would have been among the properties of the best products, being fully aware that this would constitute a content-centred rather than a user- or experience/satisfaction evaluation.

3.3 Methods

3.3.1 Eligible EBP point-of-care services

This study focused on EBP point-of-care services that can be broadly defined as “web-based medical compendia specifically designed to deliver pre-digested, rapidly accessible, comprehensive, periodically updated, and evidence-based information (and possibly also guidance) to clinicians” (see Table 3.2 for definitions). Thus, in order to be included in our analysis a product had to be an online delivered tertiary publication (summary), regularly updated, claiming to provide evidence-based information to physicians and other professionals, to be used at the bedside. As previously stated, the term “point of care” indicates the point where patients and practitioners interact, particularly referring to the context of the provider – patient dyad. Here, “point of care” applies to a summarised reference content describing alternative options in clinical practice, rather than technical solutions optimised for the use at the bedside. We restricted our analysis to services published in English as primary language.

Table 3.2. Definitions of the main criteria for inclusion/exclusion

<p>Evidence-based practice: the process of systematically finding, appraising, and using contemporaneous research findings as the basis for clinical decisions. Evidence-based practice follows four steps: formulate a clear clinical question from a patient's problem; search the literature for relevant clinical articles; evaluate (critically appraise) the evidence for its validity and usefulness; implement useful findings in clinical practice.</p> <p>Point of care: any service provided to patients at the bedside or during patients' consultations. This term refers to the</p>	<p>Summaries (tertiary literature): abstract which integrates evidence from many sources (primary literature, systematic reviews, guidelines, etc.) to provide a full range of information on management options for a given health problem.</p> <p>Systems (decision aid): clinical information systems which integrate and summarise all relevant and important research evidence about a clinical problem, and automatically link, through an electronic medical record, a specific patient's circumstances to the relevant information.</p>
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specific point in the workflow when health professional and patient interact.

Up date: renovation or integration of content within a period of maximum of five years.

Studies (primary literature): publication which illustrate or comment original scientific research findings, typically journal articles.

Synthesis (secondary literature): published materials which provide an examination of recent or current literature. Review articles can cover a wide range of subject matter at various levels of completeness and comprehensiveness based on analyses of literature that may include research findings. The Cochrane Library, Evidence-Based Medicine are examples.

Synopsis: selection and summary of clinically important articles in the medical literature usually in specific fields which includes newly published, high-quality, clinically relevant original studies and systematic reviews. Journal club and EBM online are examples.

Literature surveillance alerting systems: regular monitoring of a defined set of journals and the reporting of an article selection on the basis of validity and relevance (i.e. Evidence UpDates, ACP Journal Club, InfoPOEMs)

Meta-lists: information retrieval tools that contain links to other relevant sites on the Web. The links are usually collected by the meta list site coordinator who acts as a clearing house.

Search engine: information retrieval tools aimed at searching for information on the whole Web or on medicine-specific websites. The strength of a medicine-specific search engine its ability to filter out any sites that are not (according to programmed criteria) medical sites.

Rapidly accessible: content should be easily available on searching by keywords or browsing by topics or alphabetically ordered menus. The research output should be sufficiently summarised and relevant.

The following online information resources were excluded: (i) guideline databases as they are intended to provide recommendations rather than information; (ii) medical meta-lists

and search engines (medicine-specific and general) as they point the user toward the right place to find information rather than providing information themselves (Graber et al., 1999); (iii) literature surveillance alerting systems as they monitor a defined set of journals reporting articles selected for validity and relevance; (iv) online books as they are not regularly updated; (v) original studies reported in medical journals, practice articles, abstracts of papers (primary literature); (vi) secondary literature as it primarily comprises synthesised content (level 2 on Haynes) (Haynes, 2006). No restrictions were placed on product development status, disease or medical area, access or charging agreements.

3.3.2 Identification of EBP point-of-care services

To our knowledge, there is no single repository of online information summaries. In order to retrieve relevant databases we performed a Medline search using the following terms: ((“Evidence-Based Medicine”[Mesh]) AND (“Information Storage and Retrieval”[Mesh])) AND ((“Online Systems”[Mesh]) OR (“Point-of-Care Systems”[Mesh])).

We collected additional information from the references cited in the papers retrieved. Google was extensively used as search-engine to explore products not reported in the medical literature but available on the editorial market. The following terms were used: “Medical Information System”, “Point of Care”, “Evidence-Based Medicine”. We also screened several publisher and librarian association websites, such as the Council of Science Editors (Council of Science Editors, 2008), the World Association of Medical Editors (World Association of Medical Editors, 2008), the Medical Librarian Association (Medical Librarian Association, 2008), the European Association for Health Information and Libraries (European Association for Health Information and Libraries, 2008), and the American Medical Informatics Association (American Medical Informatics Association, 2008). Finally, we analysed the publishing products presented at several scientific information conference and exhibitions during the period 2006-2008, such as the London Online Information Expo and Medical Library Association Meeting and Exhibition (2008 Chicago, 2007 Philadelphia, 2006 Phoenix).

We repeated our search and collection during the one-year period between January and December 2008.

3.3.3 Information sought in each EBP point-of-care summary

For each database two reviewers independently retrieved information through an analysis of the official website. As reported below, we extracted EBP point-of-care services general

characteristics, coverage and breadth of the conditions considered, and information regarding the quality of the editorial process and EBP approach to content development (evidence-based EB methodology). Decisions to select items describing these features were informed by evidence, whenever possible. Detailed operational definitions are reported in Appendix 1.

The features selected were qualitatively described; for editorial and EB methodology indicators an empirical quantitative evaluation was also included, in order to give a score for each item and rank the EBP point-of-care services. For each quality indicator a point score was assigned: three points if the quality indicator was completely fulfilled, one if partially fulfilled or unclear, and 0 if not fulfilled or not reported. We arbitrarily decided to award three points instead of two for adequate fulfilment to give more weight to a more transparent and accountable reporting style and increase the variability within the sample. Our ‘incentive’ policy is somewhat similar to the three-points-for-win in soccer rule (Shepotylo, 2005). See Appendices 2 and 3 for details.

General characteristics

We first sought general information such as name, year of first release, and vendor and/or publisher; we also reported the marketing claim as stated in the homepage and/or in the “About us” section. We collected information on different formats (online, desktop, PDA, etc.) and whether the website is open-access or a subscription fee is required to access the whole content. In the latter case, types of subscription (single user, institutional, “à la carte”, pay per view) and the costs for a single-user subscription per year were reported. We also described the primary target audience (general practitioners, specialty physicians, etc.) and any other health care figures who could benefit from the contents.

Content presentation

We described the content presentation in terms of type of output (narrative or key point summaries, answers to clinical questions format), formal ontology of information and output summary flexibility. We analysed whether the output includes references, either general, suggesting further sources on a particular topic, or specific, supporting each statement. We also explored whether besides information, the EBP tool has the intent to provide recommendation to practitioners, and if so, whether a formal grading system for the strength of recommendation was used. Lastly, we sought for CME programmes and

other educational resources and a plain language content specifically developed for patients.

Coverage

We sought to describe the breadth of the medical conditions considered in terms of areas covered by the summaries (general information-epidemiology, aetiology, physio-pathology, diagnosis, treatment, follow up, prognosis). As we were not able to identify a reliable measure of database coverage, we estimated the number of diseases covered by analysing a random sample of ICD-10 chapters as a rough proxy of the comprehensiveness of the information tool (external validity). Four out of 22 (20%) ICD-10 chapters were randomly selected and sections (blocks) reported in the selected chapters was assessed in each EBP point-of-care summary (World Health Organization (WHO), 2008).

In addition, we reported information on topics other than medical conditions (e.g. medical procedures, legal issues, etc.) and whether the summary comprised more complex technologies, such as electronic medical records, drug databases, and calculators.

Editorial Quality

To evaluate the methodological quality of the editorial process, we selected specific indicators of transparency: authorship, peer reviewing procedure, updating, disclosure of authors' conflict of interest, and commercial support of content development. For each quality indicator points were assigned (3=adequate, 1=unclear, 0=not adequate/not reported). See Appendix 2 for details.

Evidence-Based Methodology

To obtain information on the evidence based approach to content development of each product, we specifically selected the following EB methodology indicators. The indication of whether contents are based on a systematic literature search or surveillance aimed at identifying relevant, valid articles was considered of primary importance. The critical appraisal methodology was also analysed and we focused on the cumulative or discretionary approach to the evidence, reporting whether systematic reviews, particularly Cochrane reviews, were preferred over other types of publication. We also looked at the availability of a system to assess quality of evidence. Finally, if expert opinion was included in the content development, we analysed whether this contribution could be easily recognised within the body of evidence.

Similarly to the editorial policy quality, for each quality indicator points were assigned (3=adequate, 1=unclear, 0=not adequate/not reported). See Appendix 3 for details.

3.3.4 Data extraction

Data were extracted by two independent reviewers using a predefined ad hoc form. We obtained general features and several information on the editorial policy and content development from thorough analysis of the website pages freely available (i.e. homepage, about us, editorial policy, and methodology description sections). When subscription was not available at our institution, the free trial and sample topics were used to acquire further information on the content characteristics and type of output. We assumed that sample topics would likely provide users with the “best” of the product as these parts are often written with the most zeal and attention. When necessary, editors were contacted by e-mail. When we could not access the content, the products were considered but excluded from the analysis. Disagreements were resolved by discussion between the reviewers and a referee.

We registered and stored within an electronic archive (December 2008) all the web pages used to extracting data.

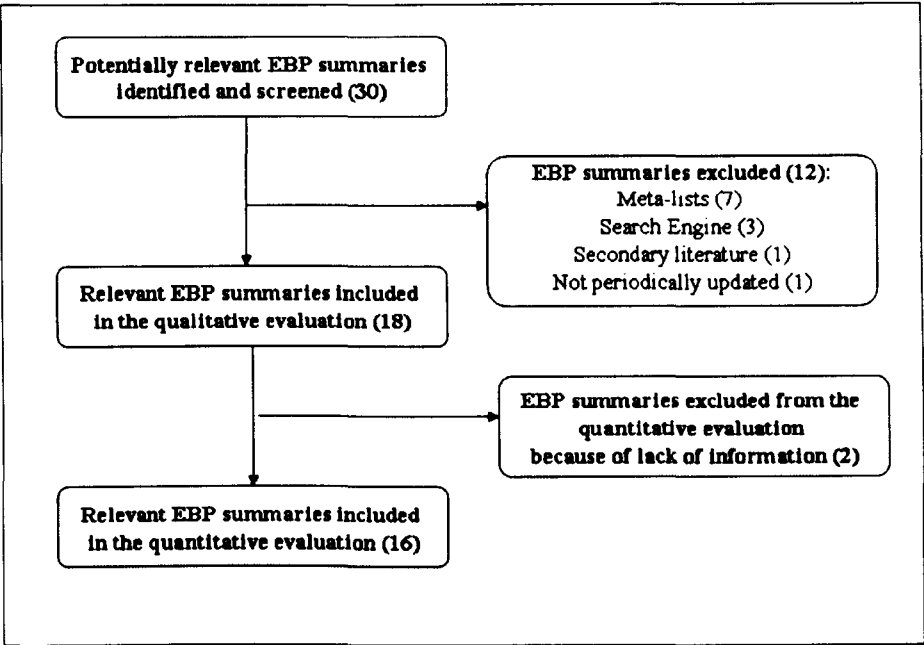
3.3.5 Analysis

Results are presented as median and inter-quartile ranges to describe coverage and quality indicator scores. The EBP point-of-care products were ranked on the basis of (i) the number of diseases covered (calculated on a random sample of ICD-10 chapters); (ii) their editorial quality (defined on the basis of adherence to the items reported in Appendix 2); and (iii) the use of an evidence-based approach (defined on the basis of adherence to the items reported in Appendix 3). The relationships between these factors were analysed by applying the Spearman rank correlation coefficient.

3.4 Results

From January to December 2008 we screened 30 eligible EBP point-of-care summary websites (Figure 3.2). Of these, 12 were excluded (for details see Appendix 4) and 18 met our inclusion criteria and were qualitatively evaluated. Two services (Zynx Health and Health Gate) were excluded from the quantitative analysis because of a lack of information on the website general pages and unavailability of sample chapters; we attempted to acquire the missing information from vendors but received no answer.

Figure 3.2. Flow diagram of the EBP point-of-care services included in the analysis



3.4.1 Qualitative analysis

General characteristics and summary content presentation features are summarised in Tables 3.3 and 3.4. In the EBP point-of-care services coverage, we found no variability in the areas of medical conditions covered (data not tabulated). With the exception of Clinical Evidence, all the services reported general information-epidemiology, aetiology, pathophysiology, diagnosis, treatment, follow-up and prognosis for each topic but they differed in terms of widening and length. Clinical Evidence focuses mainly on treatment alternatives and diagnosis and testing are not systematically covered. Several services present topics other than medical conditions, such as medical procedures (5-minutes Consult, ACP Pier, Dynamed, eMedicine, EBM Guidelines, First Consult), ethical and legal issues (ACP Pier, GP Notebook), and drug information (Dynamed, Harrison’s Practice, Micromedex, Pepid), with summaries of product characteristics and pharmacokinetic interaction tables. More complex content and integration with other technologies, such as electronic medical records (Zynx Health), drug databases (Micromedex), and calculators (Pepid) are distinctive of some products, according to the shift from summary to systems described in the Haynes model (Haynes, 2006).

3.4.2 Quantitative analysis

The EBP point-of-care services coverage based on four random samples of ICD-10 chapter analysis is estimated in Figure 3.3. The median coverage was 80.6% (interquartile range: 68.9-84.2%). There was a large differences among services, with Dynamed, EMedicine, and First Consult being the most comprehensive (88%) and eTG the least (45%).

Editorial policy quality and EB methodology are summarised in Tables 3.5 and 3.6. The median scores were 8.0 (interquartile range 5.8-10.3) and 10.0 (interquartile range 1.0-12.8) on a 15-point scale.

EBP point-of-care summary scores were ranked according to coverage, editorial and EB methodology scores (see Appendix 5). Dynamed, EBM Guidelines and UpToDate came in the top quartile for two out of three variables and in the second for the third (Figure 3.4). However, no association was found between the pairs of variables for each EBP point of care summary (Spearman rank correlation test: editorial quality and coverage $\rho = -0.00075$, $P = .998$; EB methodology and coverage $\rho = -0.191$, $P = 0.48$; editorial and EB methodology $\rho = 0.433$, $P = 0.094$).

EBP services were classified by rank, using score quartiles (Table 3.5 for editorial quality, Table 3.6 for EBP methodology, and Figure 3.3 for coverage).

Table 3.3. General characteristics of EBP point-of-care services

Name	Year of release	Vendor/ Publisher	(Marketing) claim	Fee- based/ Open access	Type of subscription	Format	Annual cost (single user account)	Target
5-minutes consults	Not reported	Wolters Kluwer- Lippiccott Williams and Wilkins	Updated regularly for quick reference at the point of care.	Fee- based	Single user	Online, PDA, smartphone , print	\$89.9	Not reported
ACP Pier	Not reported	American College of Physicians	Find authoritative , evidence- based guidance to improve clinical care	Open access to ACP member s	Not Applicable	Online and PDA	Not Applicable	Internal medicine specialists
BestBets	1996	Department of Emergency Medicine, Manchester Royal Infirmary	... provide rapid evidence- based answers to real-life clinical questions, using a systematic approach to reviewing the literature.	Open access	Not Applicable	Online and print	Not Applicable	Emergency medicine specialists
CKS	1998	NHS	Safe practical clinical answers- fast	Open access	Not applicable	Online and print	Not applicable	GPs, nurses, pharmacists, students; medical librarians
Clinical Evidence	1999	BMJ Publishing group	The international source of the best available evidence on the effects of common clinical interventions	Fee- based	Single user, institutional, pay per view, season ticket	online, print (handbook), PDA	£137/€203 / \$260	GPs, specialists
Dynamed	Not	EBSCO	Designed for	Fee-	Single user,	Online,	\$350	GPs,

	reported	Publishing	use at the point-of-care, providing best available evidence and updated daily.	based	institutional	PDA		specialists
EMedicine	1996	WebMD-Medscape	Continually updated clinical reference [...] the most authoritative and accessible point of care medical reference available to physicians.	Open access	Not applicable	Online	Not applicable	GPs and other healthcare professionals
eTG Complete	1978	Therapeutic Guidelines Limited (Australia)	Therapeutic Guidelines ... evidence in context	Fee-based	Single user, student subscription	Online, desktop, print, PDA	A\$300.00	Not reported
EBM Guidelines	1989	Wiley Blackwell Interscience and Duodecim	Easy to use clinical guidelines supported by sound scientific evidence	Fee-based	Single user, institutional	Online, print, PDA	\$255	GPs
First Consult	1997	Elsevier	Evidence-based answers for the point of care	Fee-based	Single user, institutional	Online, PDA	\$449 "Core + first consult"	GPs, specialists
GP Notebook	1995	Oxbridge Solutions Ltd	A UK medical reference on the world wide web	Open Access	Not applicable	Online	Not applicable	GPs
Harrison's Practice	Not reported	Mc Graw Hill	Answers on demand at the point of care	Fee-based	Single user, institutional	online, PDA, wireless version	\$325	GPs, Internal Medicine Specialists
Health Gate	Not reported	HealthGate Data Corporation	The latest evidence-based	Fee-based	Not reported	Online	Not reported	Providers, payers, employers,

			clinical information					and patients
Map of Medicine	2001	Hearst Corporation	Support for clinical practice national, local and personal evidence- based content broad in scope	Open access to all NHS staff in England and Wales.	Not applicable	Online	Not applicable	GPs and other health professionals
Micromede x	Not reporte d	Thomson Reuters	Evidence- based answers to support your disease management and treatment decisions.	Fee- based	Not reported	Online, PDA	Contact for pricing	GPs, specialists, other health professionals . Medical school faculty and students, librarians
Pepid	1994	Pepid LLC	The only "all-in-one" point-of-care medical reference tool available on the <i>Internet</i>	Fee- based	Single user, institutional	Online, PDA, Mobile Wireless	\$199.95 Primary Care Plus PCP	GPs, specialists
UpToDate	1992	UpToDate, Inc	UpToDate is an evidence- based, peer- reviewed information resource	Fee- based	single user institutional, patient subscription	Online, desktop, PDA	\$495	GPs, specialists
Zynx Evidence	Not reporte d	Zynx Health Incorporate d	Evidence- based healthcare. Informed decision. Improved care.	Fee- based	Not reported	Not reported	Not reported	GPs, specialists

Table 3.4. Content presentation of EBP point-of-care services

Name	Output Presentation					Strength of recommendation formal system	Education		Patient handout
	Type of output	Formal ontology	Summary flexibility	References	Intent to recommend		CME programs	Other educational material	
5-minutes consults	key point summary	Yes	No	Yes, general	Yes	No	No	No	Yes
ACP Pier	key point summary	Yes	Yes	Yes, specific	Yes	No	Yes	No	Yes
BestBets	answers to clinical questions	Yes	No	Yes, specific	No	No	No	Yes, methodology	No
CKS	key point summary	Yes	Yes	Yes, general	Yes	No	No	No	Yes
Clinical Evidence	Narrative summaries on clinical questions	Yes	Yes	Yes, specific	No	No	Yes	Yes (statistics and methodology)	Yes
Dynamed	key point summary	Yes	No	Yes, specific	Yes	Yes	Yes	No	No
EMedicine	Book chapter-like summary	Yes	No	Yes, general	Yes	No	Yes	No	No
eTG Complete	Book chapter-like summary	No	No	Yes, general	Yes	No	No	No	No
EBM Guidelines	key point summary	Yes	No	Yes, specific	Yes	No	No	No	No
First Consult	key point summaries	Yes	Yes	Yes, general	Yes	No	Yes	No	Yes
GP Notebook	Book chapter-like and key point summaries	No	No	Yes, general	No	No	Yes	No	No
Harrison's Practice	key point summaries	Yes	No	Yes, general	Yes	No	Yes	No	No
Health Gate	No information	No information	No information	Yes, general	No information	No	No	No	Yes

Map Of Medicine	Clinical pathways	Yes	Yes	Yes, specific	Yes	No	No	No	No
Microme dex	key point summarie s	Yes	Yes	Yes, specific	Yes	Yes	No	No	No
Pepid	key point summarie s	Yes	No	No	Yes	No	No	Yes	No
UpTo Date	Book chapter- like summarie s	Yes	No	Yes, specific	Yes	Yes	Yes	No	Yes
Zynx Evidence	key point summary	Yes	No	no informati on	Yes	no Information	No	No	No

Figure 3.3. **EBP point-of-care summary coverage estimated on four random chapters of the ICD-10 classification (alphabetical order)**

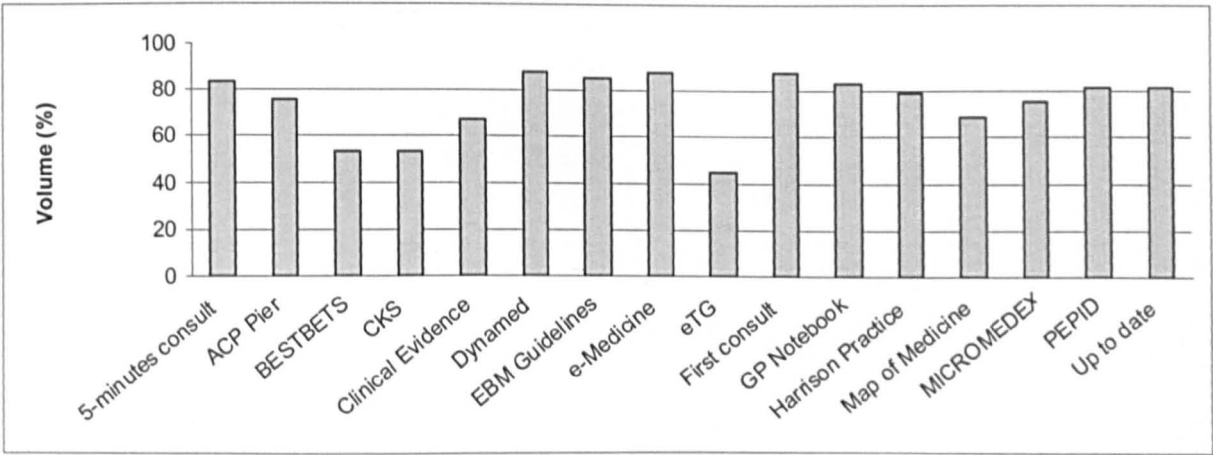


Figure 3.4. **EBP point-of-care summary ranking**

Colors: black, bottom quartile; dark grey, low intermediate quartile; light grey, high intermediate quartile; and white, top quartile.

	Coverage	Editorial Quality	EB Methodology
5-minutes consults	light grey	black	black
ACP Pier	dark grey	light grey	light grey
BestBets	black	dark grey	white
CKS	black	dark grey	light grey
Clinical Evidence	black	white	white
Dynamed	white	white	light grey
EBM Guidelines	white	light grey	white
EMedicine	white	white	dark grey
eTG	black	light grey	dark grey
First Consult	white	dark grey	dark grey
GP Notebook	light grey	black	dark grey
Harrison's Practice	dark grey	black	dark grey
Map Of Medicine	dark grey	dark grey	light grey
Micromedex	dark grey	black	light grey
Pepid	light grey	light grey	dark grey
UpToDate	light grey	white	white

Table 3.5. Editorial quality of EBP point-of-care services

Name	Authorship	Reviewing	Updating	Authors' conflict of interest	Commercial support to content development	EDITORIAL QUALITY SCORE
Clinical Evidence	Yes (3)	Yes (3)	Yes (3)	Yes, implemented and reported (3)	Not accepted (3)	15
UpToDate	Yes (3)	Yes (3)	Yes (3)	Yes, implemented and reported (3)	Not accepted (3)	15
EMedicine	Yes (3)	Yes (3)	Yes (3)	Yes, implemented and reported (3)	Accepted and disclosed (1)	13
Dynamed	Unclear (1)	Unclear (1)	Yes (3)	Yes, implemented and reported (3)	Not accepted (3)	11
eTG	Unclear (1)	Yes (3)	No (0)	Yes, implemented and reported (3)	Not accepted (3)	10
ACP Pier	Yes (3)	Yes (3)	Yes (3)	No information (0)	No information (0)	9
EBM Guidelines	Yes (3)	Yes (3)	Yes (3)	No information (0)	No information (0)	9
Pepid	Yes (3)	Yes (3)	Yes (3)	No information (0)	No information (0)	9
First Consult	Yes (3)	Unclear (1)	Yes (3)	No information (0)	No information (0)	7
BestBets	Yes (3)	Yes (3)	No (0)	No information (0)	No information (0)	6
CKS	No (0)	Yes (3)	Yes (3)	No information (0)	No information (0)	6
Map Of Medicine	No (0)	Yes (3)	Yes (3)	No information (0)	No information (0)	6
Micromedex	No (0)	Yes (3)	Unclear (1)	Yes, implemented but not reported (1)	No information (0)	5
5-minutes consults	Yes (3)	No (0)	Unclear (1)	No information (0)	No information (0)	4
GP Notebook	No (0)	Unclear (1)	Yes (3)	No information (0)	No information (0)	4
Harrison's Practice	No (0)	No (0)	Yes (3)	No information (0)	No information (0)	3

Table 3.6. Evidence-based methodology of EBP point-of-care services

Name	Literature search/ Literature Surveillance	Cumulative vs. discretionary approach	Critical appraisal	Formal grading of evidence	Cite expert opinion	EB METHODOLOGY SCORE
BestBets	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)	15
Clinical Evidence	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)	15
EBM Guidelines	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)	15
UpToDate	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)	15
Dynamed	Yes (3)	No (0)	Yes (3)	Yes (3)	Yes (3)	12
Map Of Medicine	Yes (3)	Yes (3)	Yes (3)	No (0)	Yes (3)	12
Micromedex	Yes (3)	Yes (3)	Unclear (1)	Yes (3)	Unclear (1)	11
ACP Pier	Yes (3)	No (0)	Yes (3)	Yes (3)	Unclear (1)	10
CKS	Yes (3)	Yes (3)	Unclear (1)	No (0)	Yes (3)	10
Pepid	Unclear (1)	Unclear (1)	No (0)	No (0)	No (0)	2
EMedicine	Unclear (1)	No (0)	No (0)	No (0)	No (0)	1
eTG	Unclear (1)	No (0)	No (0)	No (0)	No (0)	1
First Consult	Unclear (1)	No (0)	No (0)	No (0)	No (0)	1
GP Notebook	Unclear (1)	No (0)	No (0)	No (0)	No (0)	1
Harrison's Practice	Unclear (1)	No (0)	No (0)	No (0)	No (0)	1
5-minutes consults	No (0)	No (0)	No (0)	No (0)	No (0)	0

3.5 Discussion

3.5.1 Summary of key findings

As of December 2008, we found 18 products that could be classified as EBP point-of-care services. This suggests that several publishing groups and public health organisations are investing a remarkable amount of energy in this endeavour. The overall characteristics of these products tend to vary and evaluation of their quality is still in its infancy despite the emerging consensus that such information tools are professionally and scientifically essential (Ebell, 2003). Only few products satisfied our criteria, with none excelling in all. Thus, at present no clear set of dimensions for deciding among different products can be drawn. The choice of an information tool will depend on the properties of the resource and users' preference, according to the personal weight attached to different rankings.

3.5.2 Our study in context

One mainstay of evidence-based information mastery is the combination of tools that filter literature for relevance and validity and present summaries easily and in a quickly accessible form at the point of care (Ebell and Shaughnessy, 2003). Since doctors have huge information needs in their practice (Ely et al., 2002, Osheroff and Bankowitz, 1993), we wonder whether all these products are reliable and really improve access to high-quality information to ameliorate health care. While many user-centred or experience/satisfaction analysis were published (Alper et al., 2001, Burkiewicz et al., 2005, Campbell and Ash, 2006, Fenton and Badgett, 2007, Hoogendam et al., 2008, McCord et al., 2007) our evaluation aims at providing an explicit way to assess the available products moving away from the misleading marketing claims by vendors.

We developed a content validity scale was using an evidence-based approach whenever possible. Desirable dimensions were included if there was evidence that not addressing a particular one was associated with an increased risk of bias and where it was clear that information was necessary to appraise the reliability of a point of care product. For some quality indicators, such as the literature retrieval process and updating, we borrowed our criteria from research on good systematic review reporting methods (Moher et al., 1999, Moher et al., 2009), assuming that these apply equally to these further synthesised information tools. Other scale dimensions, such as authors' conflict of interest and peer review, come from peer-reviewed medical journals' policies, as their quality has been extensively debated during the past years (Jefferson et al., 2007, Krinsky and Rothenberg,

1998, Smith, 2005). For other items, such as intent to recommend, there is no evidence on whether this is a good or a bad thing but anyhow we looked at it to see if an informative or a prescriptive approach prevails. Disappointingly, only 20% of the tools including recommendations formally grade their strength, whereas this is essential to assure transparency and reliability of recommendation development and interpretation. (Atkins et al., 2004a)

3.5.3 Limitations of this study

One of the limitation of our study stems from the lack of a clear definition of these editorial products. We set stringent eligibility criteria to select a specific information tool generically defined as a portable and comprehensive summary of evidence (Smith, 1996), that Haynes et al. called a summary (Haynes, 2006). Our results are only a first attempt toward a more comprehensive assessment of this rapidly evolving field. The number of EBP point-of-care services is increasing and just in the first months of 2009 at least three important vendors, JAMA, BMJ and the UK NHS launched other point-of-care products on the market. Including these newcomers in our survey would have introduced heterogeneity in our time series but they will have to be monitored in the future.

The major limitation of this study is the arbitrariness of the scoring system. We chose a continuous scale instead of a classical star rating system to allow the correlation among categories. Category scores have not been added to make an overall score which would have been improper. Scores allow readers to grouping EBP point of care services on a quality basis and detect top performers only within categories. This scoring system should be considered a preliminary approach to rate EBP point-of-care services: introduction of other categories may change scores.

We did not formally analyse website navigability and usability as this goes beyond the scope of our study. It might be valuable from the users' perspective as on the web information can be communicated in many ways –as diagrams, animations, linked pages, etc – which may improve comprehension. These analyses should be carefully interpreted as they suffer from the multiplicity bias – when the user is asked to compare known systems with new ones. EBP point of care services also largely differ in their length and breadth of each topic. Our evaluation could not measure this complex aspect and the inevitable variability. However, this is a crucial aspect of any information tool, as different levels of information could be valuable to answer clinical questions. This analysis based on comparison of similar chapters from different tools calls for further user-centred research.

3.5.4 Relationships between coverage, editorial quality, EB methodology

None of the associations we postulated turned out to be statistically significant. Thus, on the basis of the criteria we used, editorial quality, EB methodology and coverage appear to be independent. For example, BestBets scored among the worst as regards the coverage, with an intermediate position for editorial quality and the first position for EB methodology. The search for associations between various desirable factors can be seen as “work in progress”, suggesting that publishers have to balance these aspects and excellence in all three aspects is difficult.

3.5.5 Implications for editorial/ publishing groups

In the global trend for point-of-care products to inform clinical practice, there is room for improving the quality and increase the coverage of disease. Publishers should provide users (or purchasers in general) with transparent, easily accessible and rigorous information regarding quality features of editorial processes and content development. Our assessment is intertwined with the quality of reporting. It is possible that publishers favoured conciseness of information in their websites and omitted important editorial and methodological details. For instance a publisher may plan and do disclose author conflict of interests, but do not report this key information in its website diminishing the trustworthiness of its product.

Great efforts have been made in the last decade or two to improve the quality of reporting in randomised controlled trials and systematic reviews (Altman et al., 2001, Altman et al., 2008, Moher et al., 2009). However, there is still evidence that methods and reporting can be improved (Moher et al., 2007a, Hewitt et al., 2005, Wood et al., 2008). We should take advantage from experience obtained in the field of primary research and apply it to derivative summarised overviews, considering that these point-of-care products are still in the early development. Important initiatives to improve the reporting of health care research, such as the EQUATOR Network (Altman et al., 2008, Simera et al., 2008) should also include them.

3.5.6 Implications for clinicians

At present a clinician who wants to use an EBP point-of-care summary regularly needs to find a balance between several desirable characteristics: no product appears to be the best. Faced with a choice of services, one criterion should prevail. The judgement is complex because on top of the various desirable criteria many other dimensions could be attractive and drive the choice: CME pathways, information addressed to patients, integration with more sophisticated technologies, etc. Simply having access to high-quality and well-summarised evidence-based information is not going to answer all the questions that the doctor-patient relation raises, but it is necessary to enable doctors to identify the best options in therapy, diagnosis or prognosis for each patient. Even the most innovative information system has to rely on sound evidence to improve clinical practice, as technology is only the vehicle of the information. Quality indicators that can be used to evaluate new EBP point-of-care services can be valuable for clinicians, but also for librarians, hospital managers and policy makers who face the challenge of favouring one tool over another in their community, i.e. giving free access.

Chapter 4.

Measuring the speed of updating of online evidence-based practice point-of-care information services

4.1 Summary

Objective

Point-of-care information services provide physicians with comprehensive evidence condensed into easily digestible formats. This study evaluates the ability of international point-of-care information services to update evidence relevant to medical practice.

Design Prospective cohort bibliometric analysis

Methods Out of 18 services available in 2008, we selected the top five (Clinical Evidence, EBM Guidelines, EMedicine, Dynamed, and UpToDate) ranked for coverage of medical conditions (coverage), editorial quality and evidence-based methodology. We measured, from June 2009 to May 2010, the incidence of research findings relating to potentially eligible newsworthy evidence cited in summary contents. As sample of cumulative newsworthy evidence, we chose systematic reviews rated as relevant by international research networks (e.g. Evidence-Based Medicine, ACP Journal Club, and The Cochrane Collaboration). Monthly, we assessed whether each sampled systematic review was cited in at least one chapter of the five point-of-care information services. The cumulative updating rate was analysed using Kaplan-Meier curves.

Results

From April to December 2009, 128 SRs were retrieved, 68 from the two literature surveillance journals (53%) and 60 from the Cochrane Library (47%).

One summary's updating process clearly headed the others (Dynamed versus two seconds EBM Guidelines and UpToDate: Hazard Ratio 4.96, CI 95% 3.57 to 6.88 and 5.81, CI 95% 3.96 to 8.52, both $p=0.0001$).

Conclusions

Evidence relevant to practice is inserted at different speeds by point-of-care information services. A complementary qualitative analysis of updating modalities can only be done if publishers provide more transparent description of updating mechanisms.

4.2 Introduction

As biomedicine evolves with the accumulation of new research and publications, promising health care interventions may emerge while others may become out of date or suboptimal (Shekelle et al., 2001a, Chalmers and Haynes, 1994) Sound evidence, together with contextual factors, values, resources, etc. forms the basic framework on which health care decisions should rest. Failure to incorporate new research results into practice can affect individual and population outcomes. This is the main reason for updating any medical information sources such as clinical trials, systematic reviews, and guidelines.

Comprehensive presentation of new research findings against the background of what was already available is essential to meet doctors' needs for evidence during clinical consultations: which interventions work, which don't work, which are additional or alternative, which need more investigation, and which might be harmful. For internet-based information in particular, doctors and health professionals expect to rapidly find the latest knowledge to answer their information needs.

Point-of-care information services are web-based compendia designed to provide health professionals with comprehensive evidence condensed into easily digestible formats. Publishers encourage physicians to use them during consultations or to seek a second opinion in their clinical decision-making. To make them attractive to final users, all publishers claim these products are regularly updated. Some even make direct reference to the dynamic incorporation of the latest evidence in their commercial names.

How long does it take for the latest research findings to make their way into a point-of-care information service (also referred as information summary)? We conducted a bibliometric analysis to examine the point-of-care services updating speed, i.e. the time between a paper's publication and its citation in a point-of-care service. For this analysis, we only considered papers with implications relevant to practice.

4.3 Methods

Out of 18 point-of-care information services available in 2008, we selected five we ranked as the top five for coverage, editorial quality and evidence-based methodology (Banzi et al., 2010): Clinical Evidence, Dynamed, EBM Guidelines, EMedicine, and UpToDate. Our a priori reasoning was that updating is a desirable dimension of point-of-care services on top of others and it would have been useless to look at the updating ability of products that were suboptimal in other dimensions (on the basis of our evaluation). The decision to limit

our analysis to the top-ranking services reflected the main aim of our research, which was to help users select one services over others.

For each point-of-care information service we collected data on the updating mechanism by closely examining the website free access pages and sending emails to the information request service, as needed. This cross-sectional qualitative analysis was done only once, in December 2009.

To evaluate point-of-care service updating speed we used a prospective cohort design over a prolonged timeframe. From June 2009 to May 2010, we measured the incidence of research findings cited in point-of-care information services on newsworthy piece of information potentially eligible.

As sample of information relevant to practice, we choose systematic reviews (SRs) which aim to provide a comprehensive appraisal of evidence. Findings from a single clinical trial are often rapidly contradicted by subsequent studies and low-bias SRs may help to get closer to the unknown “true evidence” (Ioannidis, 2005). High-quality SRs and other-design original articles on primary research are also differently rated and used by physicians, who generally favour SRs (McKinlay et al., 2008).

We selected all the SRs signalled by the American College of Physicians (ACP) Journal Club and Evidence-Based Medicine Primary Care and Internal Medicine from April to December 2009. These two literature surveillance journals survey a wide range of international medical journals, applying strict criteria for the quality and validity of research articles. Practicing clinicians assess studies that meet the basic validity criteria for relevance and newsworthiness and a summary is then produced for the top-rated articles. In the same period (April to December 2009) we selected all the Cochrane SRs labelled as “conclusion changed” in the Cochrane Library. These reviews are new-citation versions of updated reviews that warrant additional highlighting in the Cochrane Library (e.g. using a flag), indicating they should be read again (Higgins et al., 2008). The “conclusion changed” status implies that the review calls for a change of practice. We assumed that this sampling frame is highly representative of SRs that meet explicit quality standards and are deemed directly relevant to clinical practice.

Two reviewers independently checked whether each sampled SR was cited in at least one chapter of the five point-of-care information services. This was done monthly, at the same time for each product. Disagreements were eventually resolved by discussion between the two reviewers.

For each SR we defined “birth” as the publication date in one of the two literature surveillance journals or in the Cochrane Library; “death” as the occurrence of its citation in the monitored point-of-care information services. SRs were censored when the two investigators agreed on the inclusion of that evidence within a summary content. We excluded citations in additional reference lists, such as further or external readings and alert systems. The authors have kept an archive of all the reference web pages citing the sampled SRs.

We assessed the cumulative updating rate using Kaplan-Meier survival analyses. Univariate Cox model was used to estimate Hazard Ratio (HR) between the top-performer point-of-care information summary and the top second. The main updating analysis was planned for all SRs, irrespective of their literature surveillance or Cochrane origin. Depending on the origins, literature surveillance journals or Cochrane SRs were further analysed in two subgroups. A p-value ≤ 0.05 was considered statistically significant.

4.4 Results

Table 4.1 gives a brief description of the updating mechanism for each point-of-care information product. For EBM Guidelines information was obtained after contacting editors by email, while for EMedicine we were unable to retrieve any details on updating. Clinical Evidence declares a target updating cycle of one year and alerts readers of each specific chapter about potentially relevant new publications, providing links to the full reference (i.e. BMJ Updates). However, these contents are not inserted in the chapters or evaluated together with the existing body of evidence. EBM Guidelines, UpToDate and Dynamed refer to “a continuous update”, meaning that new research findings are incorporated into the summaries every time they are published. UpToDate is the only product that clearly reports quantitative data on the topic updated (35% of all contents during a four-month cycle).

From April to December 2009, 128 SRs were retrieved, 68 from the two literature surveillance journals (53%) and 60 (47%) from the Cochrane Library. The complete list is available from the authors on request.

One product has an updating process that markedly headed the others (Dynamed versus the two seconds EBM Guidelines and UpToDate: HR 4.96, CI 95% 3.57 to 6.88 and 5.81, CI 95% 3.96 to 8.52, both p=0.0001). The fourth and fifth-ranked point-of-care information services had survival curves close to the bottom (Figure 4.1).

Dynamed was also the first ranked when the updating rate was analysed for Cochrane and non-Cochrane SRs (Figure 4.2). Interestingly enough, the two second point-of-care services had similar updating rates when the whole sample of SRs was considered but differed when the origin of the SRs was taken into account. As expected, Cochrane SRs were more likely to be cited by EBM Guidelines than by UpToDate (Odds Ratio 0.021, CI 95% 0.005 to 0.097, $p<0.0001$, logistic regression).

Table 4.1. **Description of updating mechanisms reported in the web site of each point-of-care information summary**

Point-of care information service (url)	Updating policy description
Clinical Evidence (www.clinicalevidence.com)	“We aim to update Clinical Evidence reviews annually. In addition to this cycle, details of clinically important studies are added to the relevant reviews throughout the year using the BMJ Updates service. BMJ Updates is produced by collaboration between the BMJ Group and the internationally acclaimed McMaster University's Health Information Research Unit to provide clinicians with access to current best evidence from research. All citations (from over 110 premier clinical journals) are rated by trained researchers for quality, and then rated for clinical relevance, importance and interest by at least three members of a worldwide panel of practicing physicians. The final content is indexed by health professionals to allow news of studies to be added to all relevant Clinical Evidence reviews.”
Dynamed (www.ebscohost.com/dynamed/)	“The final step in DynaMed’s evidence-based methodology is changing conclusions when new evidence alters the best available evidence. This step is crucial because new evidence is published every day. Having new evidence summaries handled separately from reviewed content in a manner requiring the

	<p>clinician to search in two locations to synthesize the entire story would make finding the best available evidence more difficult. As soon as new evidence is evaluated using the 6 steps governing systematic processing, it is added to the appropriate DynaMed topic(s) in context. This process allows immediate and comprehensive access to the best available evidence as it occurs. This process occurs EVERY DAY in DynaMed.”</p>
<p>EBM Guidelines* (www.ebmj.wiley.com)</p>	<p>“Since the first electronic version was published in 1989 the contents of the database have been continuously updated. Over the years the guidelines have been extensively reviewed and even rewritten several times to include mounting evidence from clinical studies, comments by external referees, and feedback that has been collected systematically from clinicians who use the database in their daily practice. There are four updating processes that complement each other: (1) All guidelines are sent to authors and external reviewers every 2 years for systematic updates; (2) The editorial board meets once a month, and at every meeting, one speciality or a group of topics are discussed with 1 - 3 top experts on the field invited to attend; (3) The editorial team produces and updates evidence summaries continuously, and whenever the evidence summaries give rise to updates to the guidelines, the guidelines are updated; (4) The editorial teams of the translated versions of EBM Guidelines systematically check for updating needs. Updated parts of the text appear in red colour for a minimum of 6 months after the update was made.”</p>
<p>EMedicine (www.emedicine.medscape.com)</p>	<p>No detailed information on the updating policy is reported on the web site or was provided by the publisher.</p>

<p>UpToDate (www.uptodate.com)</p>	<p>“UpToDate performs a continuous comprehensive review of the resources listed above (peer-reviewed journals, clinical databases, etc.) in order to keep the program updated. Topics in UpToDate are revised whenever important new information is published, not according to any specific time schedule. Updates are integrated carefully, with specific statements as to how the new findings should be applied clinically. Each topic has a date indicating when the topic was last reviewed and/or modified. On average, approximately 35% of the topics are updated during each four-month cycle. A subset of those updates can be viewed by searching on What's New and then selecting your specialty or area of interest. These updates represent, in our editors' view, the most important new information added during the previous four months. They include Practice Changing UpDates, a compilation of studies with important or immediate implications for how clinicians practice.”</p>
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*From the editorial team.

Figure 4.1. Updating curves for relevant evidence (total SRs sample, 128) by point-of-care information services. The number of SRs at risk of being cited at each time point is indicated below the figure.

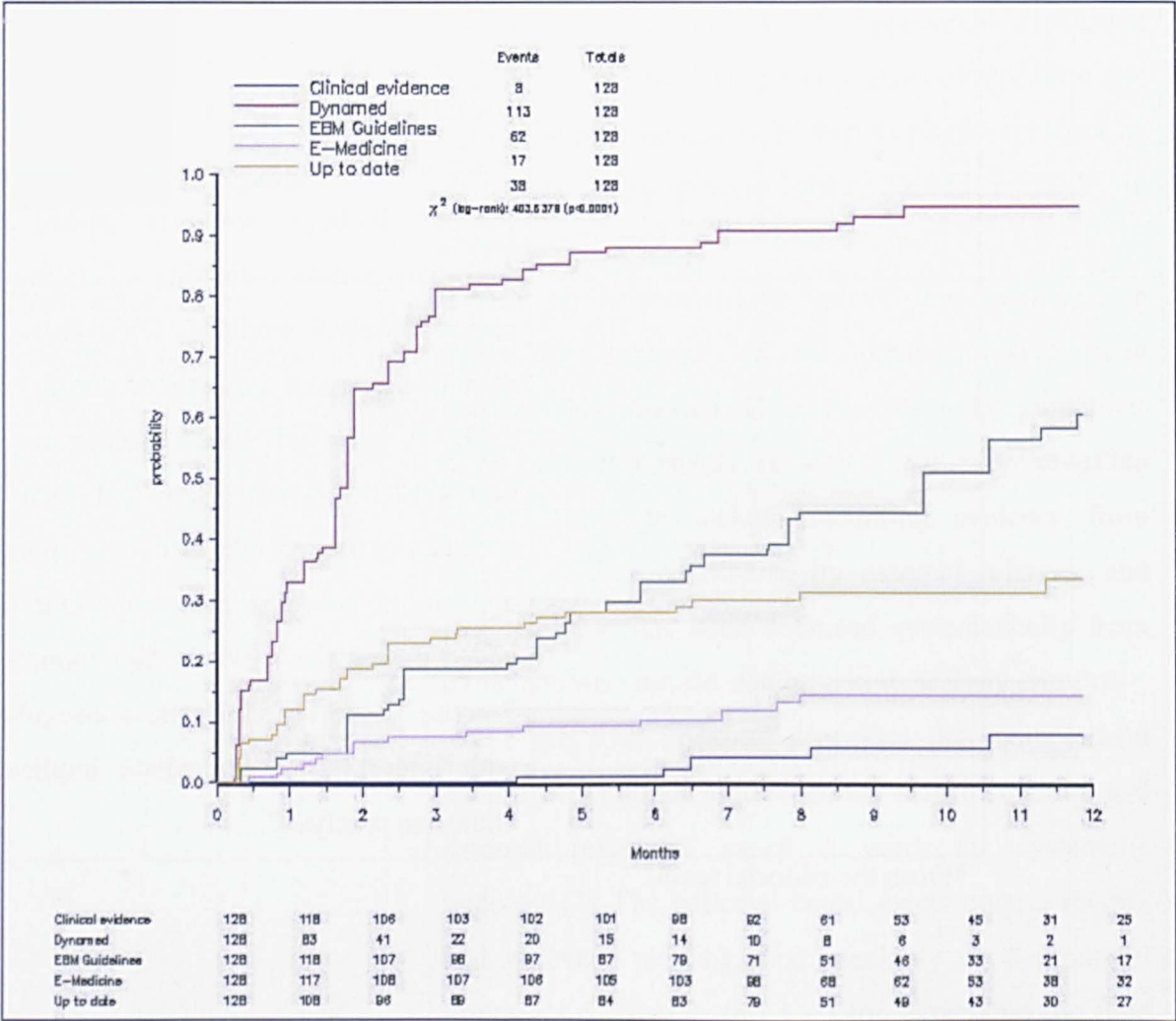
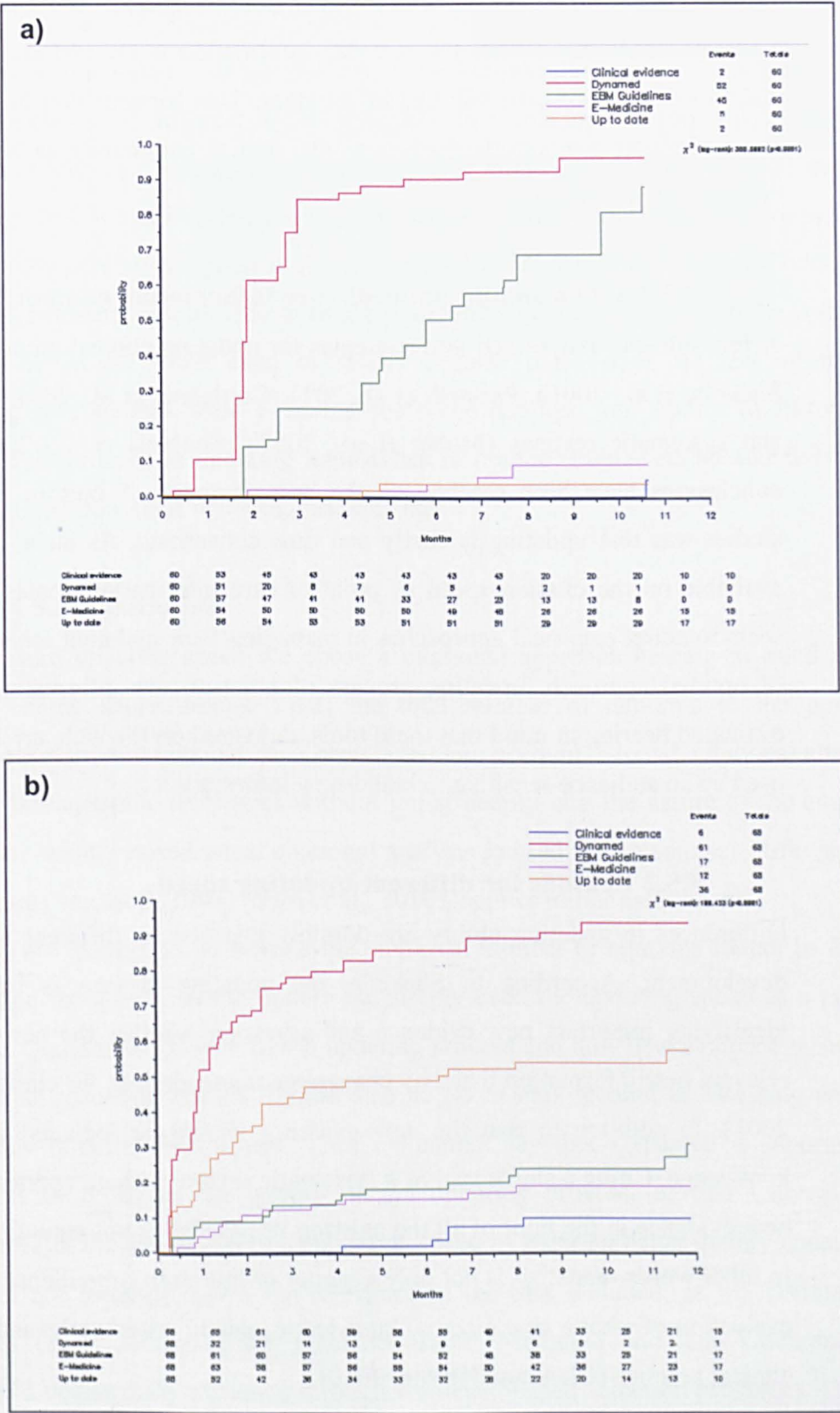


Figure 4.2. Updating curves of Cochrane (a, 60) and non-Cochrane reviews (b, 68) by point-of-care information services. The number of SRs at risk of being cited at each time point is indicated below the figure.



4.5 Discussion

This citation analysis highlights the fact that evidence held to be relevant to clinical practice is inserted at different rates into point-of-care information services. These products vary widely in their speed at updating content. Dynamed clearly dominated the other products (Clinical Evidence, EBM Guidelines, EMedicine and UpToDate). Slowness in updating could mean that new relevant information is ignored and could thus affect the validity of point-of-care information services. This happens despite the fact that many of these products promote themselves to the clinical community as being regularly updated with the latest evidence.

4.5.1 When should point-of-care information content be updated?

A few studies have looked into strategies for updating clinical guidelines (Shekelle, 2001, Shekelle et al., 2001b, Parmelli et al., 2011, Gartlehner et al., 2004, Johnston et al., 2003) and systematic reviews (Moher et al., 2007b, Shojania et al., 2007) but no definitive conclusions have been reached on the best approach. A bottom line common to these studies was that updating is costly and time consuming. As far as we know no data are available on the citation speed of point-of care information content and thus publishers seem to adopt empirical approaches in managing their updating schedule. Even in absence of optimal approach, updating process of point-of-care information services should be evaluated bearing in mind that these tools, delivered on the web, are largely intended to be used by an audience sensitive to brand-new information.

4.5.2 Reasons for different updating speed

Differences in updating ability are possibly justified by different approaches to content development. According to Shekelle, the updating process is based on two phases: identifying important new evidence and assessing whether the new evidence does carry relevant new information that may change recommendations for clinical practice (Shekelle, 2001). In addition to that the new evidence should be included in the 'old' body of knowledge. Citing a single trial or a systematic review without appraising and interpret this new evidence in the light of all the existing knowledge is not enough (Clarke et al., 2010). In other words, updating is not only a matter of literature surveillance but implies a critical evaluation of what a new piece of knowledge adds to other works and what that means for clinical practice (Clark and Horton, 2010).

Referring to these three phases, are these point-of-care information services different in their approach? Some of the products we analysed identify important new evidence by regular systematic searches or active surveillance of published journals and other information sources (e.g. reports from drug regulatory agencies, public health bodies, WHO, etc.). In this phase we detected no major differences between products. How this new evidence is judged relevant then incorporated into the body of the summary probably largely dictates the different updating speeds. In Dynamed, the top-ranked, the update is done centrally by the editorial team, and this might allow a more rapid inclusion of evidence. In Clinical Evidence, one of the lowest ranked, chapter authors are involved and often a new peer review process is required (Rubin Minhas, Past Clinical Evidence Editor, personal communication). This is time-consuming so content is likely to be updated more slowly, or, in the worst case, to simply become out-of-date. As few information on updating mechanisms were available for some services, our ability to further explore possible differences in updating approaches is limited. Publishers should fully elucidate information about their updating mechanisms.

4.5.3 Limitations

To measure updating speed we chose a citational approach bearing in mind that it can suffer some shortcomings. First, the total number of citations in the point-of-care information products should have been taken into account. Second, citational analysis only counts bibliographic references without going deeply into the nature of the citation. This criticism, widely raised when citational analysis is used to evaluate scientific productivity and quality (Kostoff, 1998) (Sarli et al., 2010), applies to our assessment.

We did not attempt to go beyond the empirical number of citations found. In fact we did not judge the quality of the update but simply used the updating speed as a proxy of its quality. Qualitative analysis of the updating process and how new evidence is incorporated and affect recommendations should also be taken into account in assessing whether one summary is better than others. Thus we cannot say that Dynamed is superior to other products in terms of the quality of the updating process, or that Clinical Evidence compensates the limitations of its updating speed by offering better quality updating.

We did not formally assess the relevance of the SRs included, as we assumed that our sources (ACP Journal Club, Evidence-Based Medicine and The Cochrane Library) highlight newsworthy evidence through well-established selection processes. Furthermore these are considered authoritative international networks that close the gap between

medical literature and clinical practice. We chose Cochrane SRs with “conclusion changed”, that are new citation versions of updated reviews that warrant additional highlighting in the Cochrane Library CDSR (e.g. using a flag), as they should be read again (Higgins et al., 2008). If a point-of-care information summary still cited the old version of the Cochrane SR this was considered not updated, regardless of the nature and impact of the change in conclusions. We believe this conservative approach, which might have partially influenced the citing speed of Cochrane SRs, was appropriate as knowing that a Cochrane SR has been updated could be important for readers.

4.5.4 Conclusions

Updating is only one aspect of a point-of-care product’s overall quality. Other studies have assessed other dimensions: user’s satisfaction, how well different online point-of-care services answered questions arising in daily clinical work, content development and evidence-based soundness (Moja and Banzi, 2010).

Findings from both user-centred and content-centred analyses need to be combined if one has to choose one product rather than another. Readers should be aware that point-of-care information services vary widely in their updating ability and in some cases it may be unsatisfactory in relation to what users expect and what is advertised by publishers. The specific intent of this paper is to provide a snapshot assessment of the updating speed of point-of-care services with recently published, relevant SRs. The quantitative findings should be considered together with a qualitative analysis of updating methods that can only be done if a more transparent description of updating mechanisms is provided.

The process leading from evidence to clinical recommendation and then to changes in behaviour is affected by many factors besides having access to the latest studies (Guyatt et al., 2008a, Guyatt et al., 2008b, Balshem et al., 2011, Guyatt et al., 2011). Nevertheless an appropriate promotion of progressed evidence is essential to provide patients with better health care interventions.

Chapter 5.

A randomised trial of a national evidence-based e-learning Continuing Professional Development program — ICEKUBE (Italian Clinical Evidence Knowledge Utilization Behaviour Evaluation)

5.1 Summary

Context

Although many countries require physicians to participate in continuing professional development (CPD) programs to foster medical competence, there are few rigorous evaluations of national CPD programs. Since 2002 doctors in Italy have had to enrol in CPD and earn 150 credits per triennium.

Objective

To assess the efficacy of national CPD evidence based e-learning program.

Design

A before-and-after pragmatic randomised controlled trial (RCT) utilising a balanced, two-by-two incomplete block design.

Intervention

General practitioners and specialists were both randomly assigned to an active intervention, an e-learning CPD program using different *Clinical Evidence* topics, interactive clinical vignettes and multiple-choice questions. Each intervention arm acted as control for the other.

Main outcome measures

Knowledge, defined as the recall of *Clinical Evidence* topics assessed from the scores for vignettes immediately before and three and six months after the intervention. Vignettes were controlled and selected for learning and development capacity.

Results

We randomised 193 participants and 104 completed the nine-month follow-up (53.9%). According to the available case analysis for topics allocated to arm A, the knowledge score at three months per physician was improved by 5.77% among physicians in the arm A intervention, but was decreased in the arm B control, with a mean reduction of 5.96% ($p=0.0204$). For topics allocated to arm B, the knowledge score at three months per physician was improved by 6.91% among physicians in the arm B intervention, and by 2.00% in arm A control ($p=0.2486$). From three to nine months follow-up, knowledge dropped in both arms. There were no significant differences in knowledge scores at nine months ($p=0.1035$ and $p=0.1201$).

Conclusions

A national online CPD based on *Clinical Evidence* and vignettes gave a modest knowledge gain than control for the first three months, but the differences were not significant after nine months. Adherence was poor and attrition high.

5.2 Background

In the last two decades many countries have recognised that continuing professional development (CPD) is a key requirement to sustain the quality of medical practice and have legislated within their health systems the revalidation and recertification of medical practitioners (Peck et al., 2000), although regulations and contents of CPD vary (Horsley et al., 2010). Most countries require doctors to acquire a certain number of credits over a defined period and describe CPD as compulsory; only a minority require some form of formal peer review.

International and national entities that supervise medical competencies are facing the challenge of building lifelong learning systems that continuously enable individuals (physicians and other health professionals) to acquire and update the knowledge and skills required for their practice. Physicians are expected to engage in learning opportunities that are reasonably free of commercial influence, learner-centred and of the highest academic quality and integrity. Traditional knowledge transfer methods are residential courses using paper-based text materials but online learning is increasingly popular, with different levels of interactivity and seems to be at least as effective as residential education (Cook et al., 2008).

In Italy, CPD is compulsory requiring doctors to earn 150 credits per triennium although there are not formal consequences (e.g. licensure is withdrawn) of failing to achieve this target. Participating in one hour of education earns one credit. The Ministry of Health through its drug regulatory agency, the Italian Medicines Agency (AIFA), sponsored an e-learning CPD national system freely available to all practicing 248,000 doctors, including 47,000 general practitioners (GPs). The system was based on *Clinical Evidence*, an electronic format compendium of the best available evidence on treating a wide range of common conditions published by the BMJ Group, and was called ECCE (the Italian acronym for Continuing Education Clinical Evidence) (Moja et al., 2007).

Objective

In this chapter I present the results of the Italian Clinical Evidence Knowledge Utilization Behaviour Evaluation Randomized Controlled Trial (ICEKUBE – RCT), which explored the effectiveness of ECCE on knowledge of general practitioners and specialist doctors. The main hypotheses that have been tested were: 1) Did an e-learning CME program based on Clinical Evidence and clinical vignettes (ECCE) increase physicians' basic knowledge

about epidemiology, therapy, prognosis, and risk factors in a clinical scenario? 2) Did physicians retain the knowledge from the ECCE for more than six months?

5.3. Methods

5.3.1 The intervention: ECCE

ECCE was an e-learning CPD tool that used interactive clinical vignettes based on chapters in *Clinical Evidence* and a predefined sequence of questions. ECCE had four components: 1) the electronic *Clinical Evidence* chapter (e.g., headache, chronic tension-type), a format that ensures links to references and to additional resources (e.g. definitions and classifications) ; 2) a clinical vignette from the *Clinical Evidence* chapter that presented a plausible medical scenario (e.g., Margaret says to her family doctor: “This time I didn’t come for me, but to talk about Rachel, my 25-year-old daughter. ...”; 3) questions addressing the recall of *Clinical Evidence* facts or their application to the medical scenario, from which the doctor is to select the correct answer; 4) the potential answers (e.g., a list of potential efficacy descriptors for a therapeutic regimen relevant to the theme); and 5) instructions on what to do (e.g., “more than one answer may be correct”).

Vignettes were intended to replicate real-life circumstances as seen by an ordinary general practitioner in everyday practice. Whilst general practitioners were the primary target of ECCE, many vignettes were also relevant to specialists. Each vignette had a narrative with events and clinical details presented in chronological order: the history evolved with new information from diagnostic tests or additional information reported by the patient. All vignettes used news media techniques, sometimes with fictional or interactive elements (e.g., mystery fiction, the possibility to order tests and obtain results in real time, test appropriateness and cost). Users solved the single steps through a question and answer decision system. They gained credits upon completing all steps where they reached a score of 80% or more of the total. Vignettes provided one or two credits depending on the number of questions. Users were required to finish the vignette started regardless of the score reached. If a user failed a module, she/he was locked out of that module by the system for 24 hours. After submitting a response, an explanation of the ideal answer was accessible to the learner, with a summary of the responses of past participants. The case had interactive tools embedded, such as checking the overall costs for the national health system of the diagnostic tests and therapeutic options ordered. Technical support was available only by e-mail on an asynchronous basis.

Both clinical vignettes and related questions have been carefully planned against Clinical Evidence chapters by ECCE authors (i.e. medical writers) who were all also specialised medical practitioners. Standardised guidelines have been developed by the ECCE program editors to support the medical writers. These guidelines considered system rules (i.e., each question has five multiple-choice answers), writing style (avoid misleading constructs such as double negatives), medical style (avoid excessive technical jargon, such as *rigor nucalis*) and provided an example framework. Each vignette has been revised by two editors to ensure it was appropriate for the *Clinical Evidence* chapter tested, and to ensure high-quality editorial standards.

ECCE had all the standard advantages of e-learning. Users selected what and when they want to learn, and at what pace. The system was easy to use and worked with basic computer requirements (e.g., low speed connection). The contents of *Clinical Evidence* could be accessed on-screen or printed and interactively managed along the steps of each vignette. The system tracked learning content and the learner's progress.

5.3.2. Experimental design

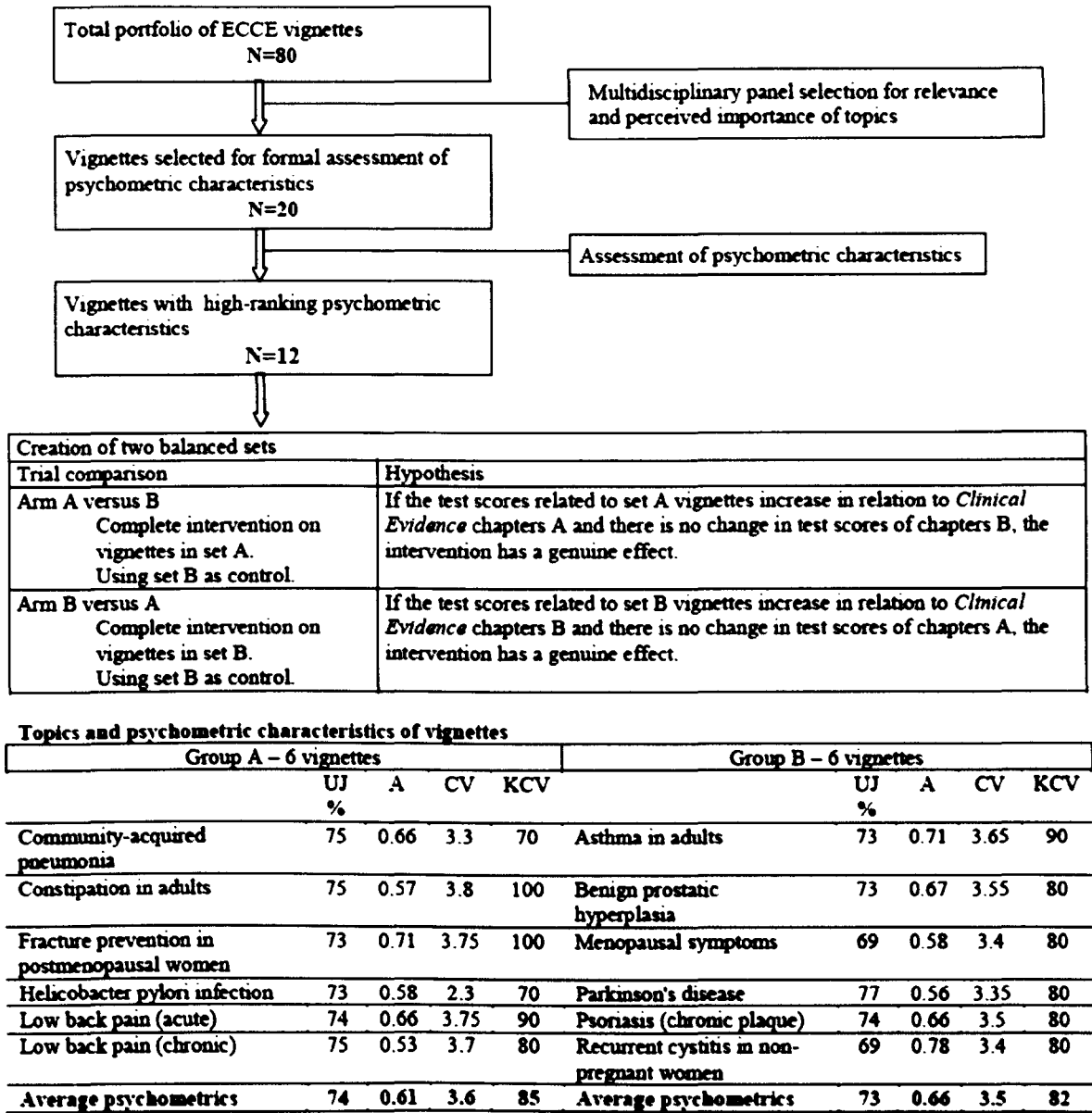
This RCT adopted a before and after two-by-two balanced incomplete block design in which subjects were randomised to an active intervention, the e-learning CPD program using different *Clinical Evidence* topics, relative interactive clinical vignettes and multiple-choice questions and provided control data for other *Clinical Evidence* topics. The control group was the other way round. When evaluating educational interventions aimed at improving clinical practice, a number of non-specific effects may influence estimates of the effect of an intervention, grouped together under the term Hawthorne effect (Cook and Campbell, 1979, Shadish et al., 2002, Eccles et al., 2003, Grimshaw et al., 2000). These include positive attention effects, caused by participants knowing that they are the subject of a study, but also negative and demotivating effects, caused by being allocated to a control rather than an intervention group. If these non-specific effects are imbalanced across study groups in a quality improvement trial, the estimates may be biased. RCTs using balanced incomplete block designs should balance such non-specific effects (Eccles et al., 2003, Shadish et al., 2002, Verstappen et al., 2003, Verstappen et al., 2004).

In details, all participants had access to totalling 14 vignettes: six intervention and eight distracter vignettes, for three months after enrolment, or until they finished all vignettes.

Doctors randomised to arm A had access to ECCE for *Clinical Evidence* 'arm A' chapters and vignettes (n=six), were inhibited access to 'arm B' chapters and vignettes (n=six), and provided control data for 'arm B' chapters and vignettes. A scheme of vignette allocation is presented in Figure 5.1. Doctors randomised to arm B had access to ECCE for 'arm B' chapters and vignettes (n=six), were inhibited access to 'arm A' contents (n=six) and provided control for arm A. The design is balanced because it ensures that all participants receive the same intensity of educational intervention and data collection, which should therefore balance any non-specific effects. The design is incomplete because not all participants receive the complete education for all chapters and vignettes.

After the intervention period, users could access a sample of another 50 vignettes until the end of the trial. These vignettes did not overlap the intervention and control vignettes for clinical contents. The ECCE e-learning platform (Zadig, Milan, Italy) tracked learning content and each learner's progress.

Figure 5.1. Selection of vignettes to evaluate the effectiveness of the e-learning CPD program, topics and psychometric characteristics



UJ: Users' judgement; α : Cronbach's α (reliability); CV: Content validity; KCV: content validity inter-rater agreement kappa coefficient.

5.3.3. Study participants

To be eligible for the study, Italian doctors were required to be naïve to ECCE. There were no other exclusion criteria. Doctors were informed about ECCE and this research program through advertisements in medical journals (i.e. *Bolletino di Informazione sui Farmaci*, a bimonthly printed bulletin focused on drug alerts and news, mailed to Italian doctors) and websites (i.e. AIFA, *Clinical Evidence* Italian version). New users who entered the ECCE website between April 2007 and February 2008 were automatically invited to participate in the trial. A computer algorithm for the allocation sequence was implemented on ECCE, assigning doctors, once they had completed registration, to one of the three arms using a balanced randomisation scheme: in this chapter the two arms of interest thereafter are identified as arms A and B. Researchers were unable to manipulate the randomisation sequence or interfere with the ECCE registration process.

5.3.4. Knowledge test

To assess knowledge and competence we adopted Miller's theory that assumes that competence predicts performance (Miller, 1990). ECCE was thought to directly affect superficial learning (ability to reproduce facts) and, with decreasing impact, deep learning (ability to apply concepts and skills in the workplace) (Fritsche et al., 2002), clinical behaviour and patients' outcomes. We adopted a conservative framework and chose change in physicians' knowledge of the *Clinical Evidence* contents as our primary outcome (Campbell et al., 2000).

From the portfolio of 80 vignettes included in ECCE, a multidisciplinary panel including representatives of GPs, the Italian Medicines Agency and consumers, selected 20 vignettes relevant to family medicine, focusing on different disorders (e.g. community acquired pneumonia, low back pain, etc). These vignettes were examined in a battery of psychometric tests to evaluate users' judgement (UJ) (expressed as positive average percentage on domains such as relevance, clarity, etc.), reliability (measured with Cronbach's α), content validity (CV) (expressed as average essentialness of items, rated by a panel of experts on a scale from 1 'not necessary' to 4 'essential') and the inter-rater agreement kappa (K) coefficient (KCV). Finally, we measured the responsiveness, the extent to which the instrument detected a change between those users who accessed the contents and those who did not.

The best 12 vignettes were selected for the experiment: six were allocated to arm A and six to arm B. To avoid contamination, vignettes in arm A and B focussed on different

conditions. To preserve comparability, vignettes were allocated to arm A or B, balancing the overall psychometric characteristics (Shaneyfelt et al., 2006, Van der Vleuten, 2000, Wass et al., 2001) and credits. The flow of vignette selection through the different phases and their psychometric characteristics are illustrated in Figure 5.1.

Knowledge was assessed from the scores in the vignettes in arms A and B before (pre-test), immediately after (approximately 12 weeks after enrolment, post-test one), and six months after the intervention (approximately 36 weeks after enrolment, post-test two). At each test time point and for each randomized doctor, ECCE randomly selected two vignettes from set A, two from set B and two distracters. To avoid repetition, ECCE excluded a previously selected vignette from the next knowledge test. Therefore, at the end of the test series, each participant was tested on all six intervention and six control vignettes, without being re-tested on the same vignette, and reducing the risk of a test-training effect. Data from all participants were collected with online instruments. Although researchers were not blinded for trial group allocation, they were not able to interfere in collection.

5.3.5. Sample size and power calculation

We calculated our sample size to detect a 0.7 standardized difference in the primary outcome, setting the α error rate at 0.05 (two-sided), and the β error at 0.10 (90% power). This yielded a sample size of 45 practitioners per study arm. We assumed 20% loss during follow-up, so the total number of practitioners to be randomised was adjusted upwards to 54 per study arm.

5.3.6. Intention-to-treat (ITT) analysis and missing outcomes

The primary analysis involved only cases available at each knowledge test, regardless of whether they had participated in the e-learning activities. The cases change at each test because of attrition. Users who agreed to participate but did not complete the pre-test (baseline observation) were omitted. This analysis is sometimes referred to as a modified ITT analysis because it does not consider all randomized subjects (Abraha and Montedori, 2010). During a masked analysis, we noticed that the rate of randomized doctors who agreed to be randomized but did not complete the pre-test was higher than had been predicted and that the study could not be completed with the sample size and power originally planned (Moja et al., 2008). We therefore amended the protocol and extended the anticipated end date (July 2007) for recruitment.

We developed three sensitivity analyses based on different cases and assumptions. To deal with missing data we planned two unmodified ITT analyses based on all randomised users. The first was based on the conservative assumption that each user who dropped out had the null scores for both tests. Missing data were replaced with zero. The second assumed that the average score of the participants who did complete the test was generalizable to all participants in the same arm. Missing data were replaced with the mean of the arm. Both approaches assume that missing values are missing completely at random. We did not use the last observation carried forward imputation method because we could not assume that the subjects' knowledge was constant from the last observed value (Molnar et al., 2009). The third secondary analysis was based on the per-protocol population, defined as the users who participated in CPD and completed all three tests. These sensitivity analyses cover a wide set of scenarios, from conservative to less cautious assumptions.

Finally we interviewed by phone all participants who did not complete the pre-test to find out why. We conducted these interviews immediately after the intervention period. Reasons covered in the interviews included whether participants had technical problems with the e-learning system or the test format itself, if the mail inviting them for the test was received in the email account, if enough background information was provided to complete the test and access the e-learning system, if there was not enough time, if the participant decided deliberately not to participate, and additional concerns/comments.

5.3.7. Statistical analyses

Knowledge test data were analysed using repeated-measure analyses of variance (ANOVA), reporting the partial omega squared (ω^2) effect size. Scores for the knowledge test scale were subjected to two-by-three repeated-measures ANOVA having one between-subjects factor (ECCE arm A and ECCE arm B) with one within-subject factor (pre-test, post-test one and post-test two) for the incomplete block design trial. Orthogonal planned contrasts were formulated for the knowledge test data to verify knowledge retention. All the analyses considered $p = 0.05$ as significant (two-sided). SAS version 9.1 statistical software (SAS Institute, Inc, Cary NC) was used.

5.3.8. Ethical approval

The study has been approved by the Research Ethics Board Azienda Sanitaria Locale "Città di Milano", Milano (file number 43-06 SO) and the participating institutions (Italian Medicines Agency, the Mario Negri Institute for Pharmacological Research and the Italian

Cochrane Centre). This study was funded by a grant from the AIFA which approved the design and the methods but had no role in its conduct, analysis, interpretation, or reporting, and did not access to the data. This trial was completely independent from the BMJ Publishing Group, which still publishes *Clinical Evidence*.

5.4. Results

5.4.1. Participants' flow and characteristics

Figure 5.2 illustrates the flow of participants through the trial. Of 193 physicians (97 arm A, 96 arm B) who agreed to participate, 156 (80.1%) completed the pre-test, 132 (68.4%) began an educational activity, 104 (53.9%) completed all learning activities, tests, and follow-up measures. The participants in the intervention and control groups were similar with regard to baseline characteristics (Table 5.1). There were no differences between randomised groups in Internet use or educational activities and no differences in baseline characteristics between participants who completed the follow-up and those who did not (Table 5.2).

In our sample, physicians were an average of 47 years old. Slightly more than two third of the participants were male (68%). Thirty-eight per cent practiced in the Northern, 39% in the Central, and 23% in the Southern geographic regions of Italy. Three-quarters (75%) were specialized in general internal medicine or general practice. Those in surgical specialties accounted for 17% of the study population. In comparison, the characteristics of the 109, 170 physicians employed by the National Health Service, in 2011, were as follow: physicians were 50 years old on average, 61% of whom were male. Thirty-eight percent were specialized in general internal medicine or general practice. Those in surgical specialties were 23%. Forty-three percent of doctors practiced in Northern Italy, 22% in Central Italy, and 25% in Southern Italy. The differences between the study sample and the whole population are likely to be due to the primary target audience of ECCE (i.e., general practitioners and internal medicine specialties) and the recruitment process (i.e. advertisements in medical journals and websites, which were directed to the same audience) (Ministero della Salute (Direzione Generale del Sistema informativo e statistico sanitaria e Direzione Generale delle Professioni sanitarie e delle Risorse Umane del SSN), 2011).

Figure 5.2. CONSORT flow diagram

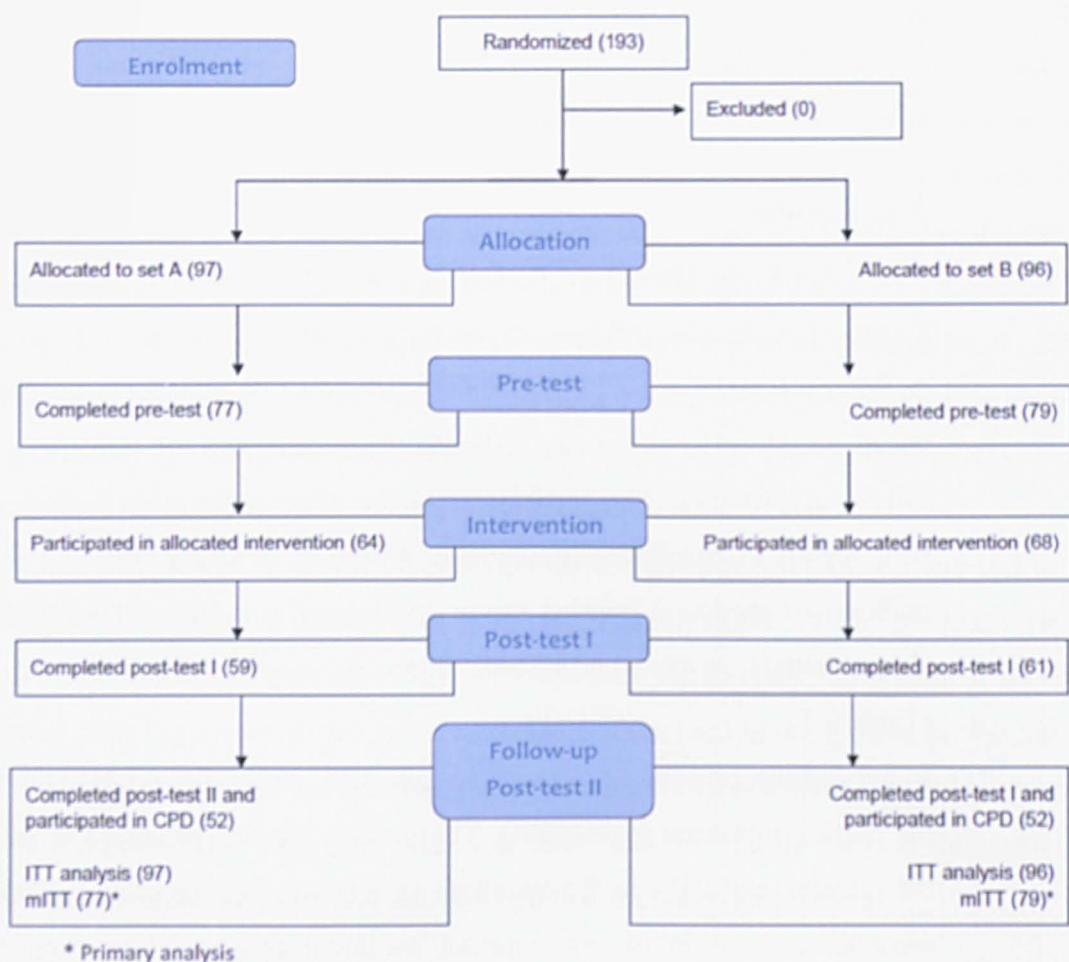


Table 5.1. Baseline characteristics of physicians in ECCE arm A and B

	Arm A	Arm B
Total physicians enrolled, No. (%)	97	96
Age		
<i>Mean ± SD</i>	47 ± 9	47 ± 9
<i>Median</i>	49	49
<i>Range</i>	26 - 67	29 - 83
Year graduated medical school, No. (%)		
<i>Before or in 1988*</i>	52 (53.6)	58 (60.4)
Sex, No. (%)		
<i>Male</i>	66 (68.0)	67 (69.8)
Location in Italy, No. (%)		
<i>North</i>	37 (38.1)	36 (37.5)
<i>Central</i>	40 (41.2)	36 (37.5)
<i>South</i>	20 (20.6)	24 (25.0)
Specialty, No. %		
<i>Medical</i>	73 (75.2)	72 (75.0)
<i>Surgical</i>	19 (19.6)	15 (15.6)
<i>Public health</i>	3 (3.1)	6 (6.3)
<i>Other</i>	2 (2.1)	3 (3.1)
Academic institution, No. %		
<i>Yes</i>	15 (15.4)	11 (11.5)
<i>No</i>	54 (55.7)	61 (63.5)
<i>Mix</i>	28 (28.9)	24 (25.0)
Total hours spent on internet per day, No. %		
<i>0-1</i>	7 (7.2)	5 (5.2)
<i>2-5</i>	30 (30.9)	31 (32.3)
<i>6-10</i>	19 (19.6)	15 (15.6)
<i>More than 10</i>	13 (13.4)	21 (21.9)
<i>Can't tell</i>	28 (28.9)	24 (25.0)
Attended meetings during the past year		
<i>0-2</i>	35 (36.0)	29 (30.2)
<i>3-5</i>	42 (43.3)	44 (45.8)
<i>Can't tell</i>	22 (22.7)	23 (24.0)
Previous e-learning experience		
<i>Yes</i>	14 (14.4)	14 (14.6)
<i>No</i>	63 (65.0)	65 (67.7)
<i>Can't tell</i>	20 (20.6)	17 (17.7)

**Table 5.2. Main baseline characteristics of users who completed the follow-up
and those who dropped out of the study**

	Completed study		Dropped out	
	Arm A (52)	Arm B (52)	Arm A (45)	Arm B (44)
Age				
<i>Mean ± SD</i>	49 (7.8)	48 (10.9)	48 (9.6)	50 (7.3)
<i>Median</i>	50	50	50	52
<i>Range</i>	44 – 54	37 – 55	46 - 55	46 – 55
Sex, No. (%)				
<i>Male</i>	37 (71.1)	36 (69.2)	29 (64.4)	31 (70.4)
Total hours spent on internet per day, No. (%)				
<i>0-1</i>	7 (13.5)	5 (9.5)	0 (0.0)	1 (2.3)
<i>2-5</i>	21 (40.4)	20 (38.5)	12 (26.7)	11 (25.0)
<i>6-10</i>	16 (30.8)	11 (21.2)	5 (11.1)	6 (13.6)
<i>More than 10</i>	8 (15.3)	16 (30.8)	8 (17.8)	9 (20.4)
<i>Can't tell</i>	0 (0.0)	0 (0.0)	20 (44.4)	17 (38.7)
Attended meetings during the past year, No. (%)				
<i>0-2</i>	10 (19.2)	10 (19.2)	3 (6.7)	4 (9.1)
<i>3-5</i>	24 (46.2)	15 (28.8)	10 (22.2)	14 (31.8)
<i>> 5</i>	11 (21.1)	18 (34.6)	8 (17.8)	8 (18.2)
<i>Can't tell</i>	7 (13.5)	9 (17.3)	24 (53.3)	18 (40.9)
Previous e-learning experience, No. (%)				
<i>Yes</i>	12 (23.1)	9 (17.3)	2 (4.4)	5 (11.4)
<i>No</i>	40 (76.9)	43 (82.7)	23 (51.1)	22 (50.0)
<i>Can't tell</i>	0 (0.00)	0 (0.0)	20 (44.4)	17 (38.6)

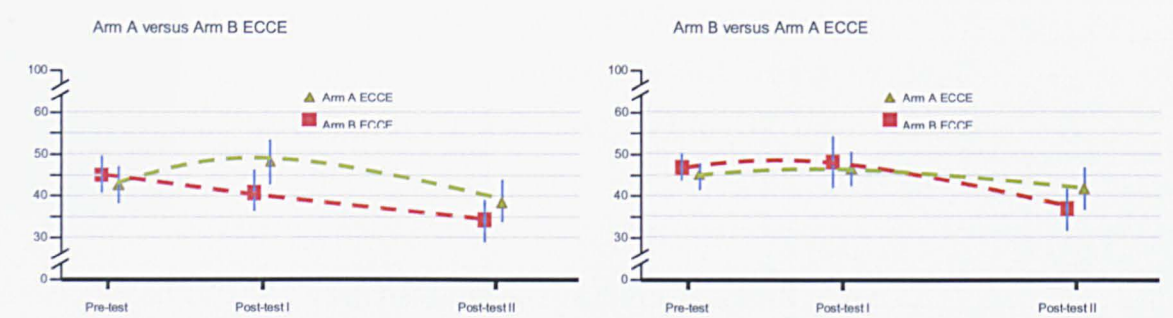
5.4.2. Use of Online Program

During the three months of intervention, 132 participants in the two arms spent a mean (SD) of 56 (107) minutes accessing vignettes, excluding the time used for tests and surveys while who completed all learning activities (n=104) spent a mean of 116 (38) minutes. Physicians spread their involvement over a median of four sessions (range 1-18), each lasting a mean (SD) of 13 (22) minutes. Users completed a median of four vignettes (range 0-14).

5.4.3. Primary analysis: available cases

The main findings for the available cases analysis are presented in Figure 5.3 and Table 5.3. From baseline to post-test I, all the changes in the intervention groups were in agreement with *Clinical Evidence* contents, in that they represented gains in the number of corrected answers. The knowledge gains were always larger in intervention groups than controls. Considering A as the intervention arm, the average gain in knowledge in the intervention (arm A) was 5.77% whereas in the control (arm B) the average felt -5.96% ($p=0.0204$). When taking B as intervention arm, both groups gained knowledge (arm A 2.00%, arm B 6.91%), although the intervention group had a larger increase ($p=0.2486$). From post-test I to post-test II knowledge dropped in the intervention and control groups. Again, the changes were always larger in the intervention group than controls. In other words, any gains in knowledge in the intervention group were followed by a decrease that was always larger in the intervention than the control group. Considering A as the intervention arm, this arm achieved more correct answers compared than the control arm B (38.99% versus 34.36%). Considering B as the intervention, it achieved fewer correct answers (37.10% versus 42.38%), with a significant difference when adjusted for previous test scores ($p=0.0048$). Finally when we compared pre to post-test II, the baseline and the last measurement, knowledge decreased in both groups, with no differences (respectively $p=0.1035$ and $p=0.1201$).

Figure 5.3. Incomplete-block design arm A versus arm B ECCE and arm B versus arm A: knowledge test mean estimates (percentage of correct answers) – modified intention-to-treat analysis based on randomized users who completed at least the pre-test, regardless of whether they participated in the e-learning activities



Error bars indicate the 95% confidence interval (CI) for mean scores.

Incomplete-block design Arm A versus Arm B ECCE: A repeated-measures ANOVA showed a significant difference in scores across time ($P=0.0036$) and between groups ($P=0.0315$) but no interaction between groups and scores across time ($P=0.0702$). Omega-squared: 0.0043; effect size: 0.066.

Incomplete-block design Arm B versus Arm A ECCE: A repeated-measures ANOVA revealed a significant difference in scores across time ($P<0.0001$) and interaction between groups and scores across time ($P=0.0179$), but not between groups ($P=0.9562$). Omega-squared: 0.008; effect size: 0.089.

Table 5.3. Effects of ECCE by ANOVA. Primary analysis: available cases analysis on changes (post-interventions minus pre-intervention) in scores for random vignette knowledge tests

Available cases analysis	Arm A tests				
	Mean (SD) %			Mean change (95% CI) %	
	Pre-test	Post-test I	Post-test II	Pre to post I [†]	Post I to post II [†]
Arm A Intervention (77) [‡]	43.20 (17.57)	48.61 (19.15)	38.99 (20.10)	5.77 (-1.58 to 13.13)	-10.86 (-19.22 to -2.50)
Arm B Control (79) [‡]	45.70 (17.90)	41.45 (19.39)	34.36 (19.14)	-5.96 (-12.73 to 0.81)	-7.16 (-15.23 to 0.91)
P value*	0.3786	0.0442	0.2316	0.0204	0.5243
	Omega-squared: 0.0043; effect size: 0.066				
	Arm B tests				
	Pre-test	Post-test I	Post-test II	Pre to post I [†]	Post I to post II [†]
	Pre-test	Post-test I	Post-test II	Pre to post I [†]	Post I to post II [†]
Arm A Control (77) [‡]	45.12 (15.22)	46.33 (16.26)	42.38 (19.30)	2.00 (-3.59 to 7.59)	-4.62 (-11.76 to 2.53)
Arm B Intervention (79) [‡]	46.19 (13.93)	47.49 (53.28)	37.10 (20.48)	6.91 (0.57 to 13.24)	-19.24 (-26.51 to -11.98)
P value*	0.6465	0.0553	0.1793	0.2486	0.0048
	Omega-squared: 0.008; effect size: 0.089				

Abbreviations: CI, confidence interval.

*Orthogonal planned contrasts from a repeated-measures analysis of variance.

[†] Mean differences in tests do not perfectly match mean score differences because number of participants differ between tests (See Figure 2).

[‡] Numbers refer only to the pre-test and decrease because of attrition in post-test I and post-test II.

5.4.5. Sensitivity analyses

In the ITT analyses, the direction and difference in the magnitude of the treatment effect appeared to depend on the type of missing data employed. Results are presented in Table 5.4. Where missing data were counted as total failures, both in the intervention and control groups average knowledge constantly decreased from pre-test to post-test II. From baseline to post-test I, the intervention groups always achieved more correct answers than controls, although these differences were not significant. Where we replaced missing data with the mean of their arms, the results confirmed our primary analysis. From baseline to post-test I, the intervention groups showed a significant gain in knowledge ($p=0.0037$ and $p=0.0340$) but again this was followed by a decrease in knowledge that in the intervention arm B reached the threshold for significance, with arm A, as control, outperforming arm B ($p<.0001$). Per protocol analysis was in agreement with the available cases analysis although there were more pronounced differences between groups.

Table 5.4. Effects of ECCE by ANOVA. Secondary analyses: ITT and per protocol analyses on changes (post-interventions minus pre-intervention) in scores for random vignette knowledge tests.

ITT – Missing data replaced with no change in scores	Mean (SD) %			Mean change (95% CI) %	
	Pre-test	Post-test I	Post-test II	Pre to post I	Post I to post II
	Arm A tests				
Arm A Intervention (97)	34.29 (23.52)	29.56 (28.11)	20.90 (24.43)	-4.73 (-10.67 to 1.22)	-8.66 (-13.57 to -3.75)
Arm B Control (96)	37.61 (23.89)	26.34 (25.29)	18.61 (22.20)	-11.27 (-16.73 to -5.81)	-7.72 (-12.73 to -2.72)
P value*	0.3316	0.4029	0.4963	0.1091	0.7909
	Omega-squared: 0.0043; effect size: 0.066				
	Arm B tests				
Arm A Control (97)	35.81 (22.81)	28.18 (26.01)	22.72 (25.48)	-7.63 (-12.90 to -2.36)	-5.46 (-9.82 to -1.10)
Arm B Intervention (96)	38.01 (21.76)	33.84 (31.42)	20.09 (23.89)	-4.15 (-9.46 to 1.65)	-13.76 (-18.46 to -9.06)
P value*	0.4946	0.1733	0.4618	0.3797	0.0109
	Omega-squared: 0.0079; effect size: 0.089				
ITT – Missing data replaced with average arm scores	Arm A tests				
Arm A Intervention (n=97)	43.20 (15.64)	48.61 (14.88)	38.99 (14.65)	5.41 (0.89 to 9.93)	-9.62 (-14.12 to -5.11)
Arm B Control (n=96)	45.70 (16.22)	41.45 (15.41)	34.36 (14.03)	-4.25 (-8.95 to 0.44)	-7.09 (-11.54 to -2.64)
P value*	0.2757	0.0012	0.0261	0.0037	0.4288
	Omega-squared: 0.0204; effect size: 0.144				
	Arm B tests				
Arm A Control (n=97)	45.11 (13.54)	46.33 (12.64)	42.38 (14.07)	1.22 (-2.36 to 4.80)	-3.95 (-7.79 to -0.11)
Arm B Intervention (n=96)	46.18 (12.62)	53.28 (17.96)	37.10 (15.01)	7.09 (2.96 to 11.22)	-16.18 (-20.43 to -11.42)
P value*	0.5694	0.0022	0.0125	0.0340	<.0001
	Omega-squared: 0.027; effect size: 0.167				

<i>Per protocol</i>	Arm A tests					
	Pre-test	Post-test I	Post-test II	Pre to post I [†]	Post I to post II [†]	
Arm A Intervention (52)	41.85 (18.46)	49.85 (19.51)	38.99 (20.10)	8.01 (0.35 to 15.66)	-10.86 (-19.22 to -2.50)	
Arm B Control (52)	46.55 (15.96)	41.52 (19.60)	34.36 (19.14)	-5.02 (-12.25 to 2.20)	-7.16 (-15.23 to 0.91)	
P value*	0.1679	0.0321	0.2316	0.0146	0.5243	
	Omega-squared: 0.0043; effect size: 0.066					
	Arm B tests					
	Pre-test	Post-test I	Post-test II	Pre to post I [†]	Post I to post II [†]	
Arm A Control (52)	43.80 (14.70)	46.99 (16.60)	42.38 (19.30)	3.19 (-2.56 to 8.95)	-4.62 (-11.76 to 2.53)	
Arm B Intervention (52)	45.80 (13.04)	56.34 (21.47)	37.10 (20.48)	10.54 (4.19 to 16.90)	-19.24 (-26.51 to -11.97)	
P value*	0.4652	0.0146	0.1793	0.0882	0.0048	
	Omega-squared: 0.008 Effect size: 0.089					

Abbreviations: CI, confidence interval.
 *Orthogonal planned contrasts from a repeated-measures analysis of variance.

5.4.6. Reasons for declining participation

Results of phone interviews are presented in Table 5.5. About half of the 37 doctors who agreed to be randomised but did not in fact take part in any activity provided reasons for not participating. The main barrier was lack of time. Only a few doctors mentioned technical problems, the only barrier that could have entirely prevented participation.

Table 5.5. Reasons for not participating

	Arm A	Arm B	Total
Number of losses*	20	17	37
Respondents	10	8	18
Reasons			
Lack of time	4	7	11
Lack of interest in topics	2	1	3
Technical problems	2	-	2
Other	2	-	6

* Doctors who agreed to participate but never took part in any trial activity.

5.5. Discussion

An e-learning intervention targeting physicians, based on evidence-based services, interactive clinical vignettes as the educational model and the CPD system regulation as the legal framework, achieved short-term gains in knowledge of around 6%. Doctors furthered their knowledge in agreement with *Clinical Evidence* accessing the CPD platform whenever they wanted during three-months, which was a relatively short intervention period. Once the intervention was removed, doctors' knowledge quickly dropped to the previous level or slightly less. We were unable to show any knowledge retention after nine months. These results can be described as mixed: where interaction between users, topics and tests, some showed that the intervention reached statistically significantly better knowledge and others showed the opposite direction. Whether e-learning increases knowledge remains a subject of debate, particularly in light of uncertainty regarding long-term retention. If it is effective, the magnitude is likely to be modest.

In a meta-analysis of 201 observational and experimental trials (Cook et al., 2008), Cook et al. suggested that e-learning significantly favoured gains not only in knowledge but also in skills and patients' outcomes (Cook et al., 2008). This meta-analysis highlighted that many primary studies adopted suboptimal designs such as uncontrolled before-and-after designs and were underpowered. Concerns also arise from the novelty effect sometimes referred to as the Hawthorne effect (Shadish et al., 2002). Our study was a rigorous randomised trial adopting a sophisticated design to balance the novelty effect across groups and measured knowledge at different time points. Our results suggest that this meta-analysis may have been more cautious in the reporting of causality of e-learning (Banzi et al., 2009, Li et al., 2009).

Other evidence for short effect of e-learning is scarce. The landmark randomised trial by Fordis et al. compared online learning with live workshops and showed similar changes in behaviour as well as sustained gains in knowledge after twelve weeks (Fordis et al., 2005). Our study had a longer follow up – 24 weeks following the intervention phase – but the knowledge gain was not maintained. In our trial doctors free access to other educational opportunities and therefore the observed benefits represent added value on the CPD e-learning program over and above the 'usual' educational activities that doctors might participate in.

Three elements make our trial unique. Firstly the learning modules are based on evidence-based authoritative syntheses of the relevant global evidence for physicians. Findings from

a single clinical trial are often rapidly contradicted by subsequent studies and low-bias systematic reviews may help health professionals to get closer to the unknown “true evidence” (Clark and Horton, 2010, Ioannidis, 2005 #146, Young and Horton, 2005). High-quality systematic reviews are used more and rated more highly by physicians in terms of relevance to clinical practice than other-design original articles on primary research (McKinlay et al., 2008). Out of 18 point-of-care information services available in 2008, *Clinical Evidence* clearly gives priority to systematic reviews over other types of publication and was ranked in the top quartile for two desirable dimensions: editorial quality and evidence-based methodology (Banzi et al., 2010).

Secondly, we used narratives to frame the modules. Narratives and stories are emerging as a promising approach to encourage practitioners to use established bodies of quantitative knowledge in clinical practice and appear more persuasive and memorable than statistics for understanding the results and implications of research (Fox, 2000) (Naldi et al., 2006) (Vandenbroucke, 2001). Peabody and al. found that vignette scores appeared to be highly correlated to physicians’ practice in outpatient settings and were a valid overall measure of the care provided (Peabody et al., 2000).

Finally, this trial is connected to a CPD program with no vested commercial interests in the development or delivery of the modules but with strong endorsement from health authorities for transfer of the knowledge.

Differences in the CPD system regulation and programmes, in the access to evidence-based summary information and in doctors’ learning needs may reduce the generalizability of the effect of this intervention across industrialized countries (Horsley et al., 2010). However, other elements favour the transferability of this e-learning CPD system: the worldwide diffusion of high-quality point-of-care services (Banzi et al., 2010) (Moja and Banzi, 2010), the basic computer and connection requirements, and the low cost for each credit provided (Moja et al., 2007). While the focus of our trial was on physicians, policies should be transferable to other health professionals as well.

This trial has three major limitations. The first deals with the choice of an intermediate outcome, change in knowledge, compared to effectiveness on physicians’ behaviour or patients’ outcomes. A cascade of events might mature and propagate from a change in awareness to health gain, although this might also not happen for several reasons, such as external barriers or the inertia of previous practice (Cabana et al., 1999). Indeed, our trial’s results may reflect physicians’ competence more than appropriate practice.

The second is the high rate of loss to follow-up. Although the 46.1% attrition rate is outside the usual value given in guidelines for instructional RCTs (Coalition for Evidence-Based Policy, 2003), we considered in advance that no face-to-face contacts between trialists and participants might lead to increased losses. The final drop-out rates, though, far outweighed our expectations. Although in a pragmatic trial it is neither necessary nor always desirable for all subjects to complete the trial (Roland and Torgerson, 1998), the results of the available cases analysis did not consider all the physicians in the group to which they were initially randomised. We cannot exclude that losses and non losses differed for because of internet 'comfort' or attitudes to educational activity attitude, since participants who dropped out were more likely to provide incomplete information. Results are indeed vulnerable to selection bias. In other words failure to complete might be related to computer skills or an unfavourable attitude or comfort to e-learning and could have introduced systematic differences between the two groups: the bias could be in either direction.

It is reassuring that once we estimated changes in knowledge to losses to follow-up, the effect of the intervention disappeared only when we used a very conservative approach. The high drop-out rate in our study occurred very early after randomisation and may indicate that attrition closely reflects baseline motivation to participate in educational activities or practical barriers in the way of participation, rather than a different impact on knowledge by the intervention itself. To minimize the bias caused by inevitable missing data, future trials might explore a run-in period and other interventions that might support trial participation (Sprague et al., 2003). In knowledge translation trials, however, it may not be possible to ascertain poor adherence until after randomization.

The third limitation is that the planned 20% minimal difference in absolute knowledge gain was not achieved. The effect of ECCE can be expressed as gains in correct answers. From baseline to post-test I the gain between the intervention and control was 1.9 correct answers every 20 questions. From post-test I to post-test II knowledge dropped to -1.8 correct answers. Although we lost some power, the results reached the statistical significance threshold for gain immediately after the intervention period. The effect size we hypothesised was too optimistic. The gain assessed by our intervention are aligned with the median effect sizes shown in meta-analyses of educational meetings and other interventions to change clinical practice (Forsetlund et al., 2009, Grimshaw et al., 2001).

Several publishing groups, health professional organisations and governmental bodies have shown interest in e-learning services for doctors, attracted by profit and/or significant value

creation. However its effectiveness in transferring knowledge has not yet been tested on a nation-wide level. Our study is one of the first and indicated there could be significant gain in knowledge. Given that it is relatively easy to implement, this educational model could be introduced at limited cost in many western countries. It may also be a case for promoting “information hubs” in which information kits widely connected with other computer systems (e.g. literature search engines, decision support, group discussion and learning interfaces) can be assembled (Moja and Banzi, 2010). This integrated learning space can provide a large audience of health professionals (doctors, nurses, etc.) with different strategies to manage their learning needs.

An e-learning intervention should not be developed as a stand-alone opportunity to promote changes in practice. Its potential, associated with other educational and quality improvement interventions, is still largely unexplored. The addition of explicit setting of goals and action plans might improve outcomes, facilitating active participation and overcoming barriers such as distraction or fatigue (Ivers et al., 2010, Pereles et al., 1996). Deep learning – the ability to apply concepts and skills in the workplace – can require additional strategies, for example, electronic reminders or audit and feedback (Jamtvedt et al., 2006, Shojania et al., 2009).

There are several qualitative dimensions associated with e-learning such as the perceived barriers to participation in educational activities and the incentives to retain knowledge over time. It is important to understand the potential impact of various agents of change better: health plans, professional organisations, legislative and regulatory frameworks, accrediting bodies, and publishers. We used *Clinical Evidence* as the basis for our educational intervention, an information service proposed by an authoritative and well-known publisher. However, this “brand” is not a guarantee by itself of optimal learning approach, so further studies are needed to elucidate the potential of instructional methods, presentation formats, and approaches for large-scale CPD e-learning programs.

E-learning programs are rapidly evolving, and the dimensions that govern their effectiveness and quality are still in their infancy despite an emerging consensus that lifelong learning strategies are professionally and scientifically essential (Horsley et al., 2010). Health professionals play a key role in creating additional value achieved from research in CPD. They have a moral and professional obligation to consent and adhere to knowledge translation research to ensure that when treatments are discovered to be safe and effective, they are actually implemented in medical practice in sustainable and

affordable ways (McRae et al., 2011). Health care quality research needs to be recognised as a socially and professionally central activity.

5.6. Supporting information

Trial Registration

This trial has the registration number ISRCTN27453314 in the International Standard Randomized Controlled Trial Number Register.

Available at: <http://www.controlled-trials.com/ISRCTN27453314/icekub>

Trial Protocol

This trial protocol was peer-reviewed and published in the Implementation Science.

Available at: <http://www.implementationscience.com/content/3/1/37>

Chapter 6.

Conclusions

6.1. Complexity

The first remark surrounding this research program is that it involved the evaluation of a multifaceted intervention that is usually reported as comprising of several interacting components (Craig et al., 2008). In this program, we evaluated a series of components, including point-of-care services according to single quality dimensions (e.g. speed of updating), e-learning as an innovative educational media, and their combined potentialities for advancing continuing medical education (CME) in graduate health professionals. The partitioning approach was necessary as it diminished the complexity of the intervention and legitimised the answering of few key questions. In terms of determining the best online resources among authoritative point-of-care summaries for guidance in clinical decision making, we found 30 eligible point-of-care services, 18 of which met the eligibility criteria (i.e. online-delivered summary that is regularly updated, claims to provide evidence-based information, and is to be used at the bedside). These products were assessed and ranked according to: (1) coverage of medical conditions, (2) editorial quality, and (3) evidence-based methodology. Overall, DynaMed, EBM Guidelines, and UpToDate scored in the top quartile for two out of three dimensions and in the second quartile for the remaining one dimension. Based on these findings, we concluded that only a few point-of-care summaries satisfied the criteria, with none excelling in all. In terms of a single dimension, the updating speed of the point-of-care service (i.e. the time between a relevant paper's publication and its citation in the information service), Dynamed was a clear frontrunner. The updating speed represents only one aspect of the overall quality of point-of-care information services; however, this dimension is important in that it determines a service's ability to transmit new and relevant information, thereby affecting the service's validity as a whole. The simple relationship between the question and the answer was lost when all of the dimensions were integrated into a wide and complex mixture of components and assessed in the ICEKUBE trial. The complexity was not only due to the intervention – an online CME program based in high quality evidence – but also to the difficulty of the construct and targeted outcome (i.e. changes in evidence based knowledge and competence by those health professionals receiving the intervention) as well as the design of the study that was adopted to minimize potential biases (i.e. incomplete block design). Given these

complexities, it is likely that only a few components of the overall intervention have been fully explored; further, the main question of the thesis - is a continuing medical education program based on high-quality evidence effective in improving the knowledge of health professionals? – may have been only partially addressed.

Useful details for the knowledge measures include the number of questions, administration time, question formatting, scoring, reliability, and validity. Despite the fact that we used a standardized approach to assess the reliability and validity of our knowledge measures, our psychometric evaluation was limited by poor generalizability, a small sample size, and the inability to establish criterion validity. Our questions examining physicians' knowledge may have had low sensitivity, low specificity, or both, limiting our understanding of the relationships between knowledge change, behaviour change, and patient health change. Future research should focus on the development of pertinent measures of knowledge, their link with competence and behaviour, and attention to cross-cultural issues.

6.2. Does the union between CME and Evidence Based Medicine (EBM) work?

Our randomised controlled trial of nearly 200 physicians revealed little evidence for a difference in health care knowledge between physicians who were exposed versus not exposed to evidence-based contents derived from a point-of-care service. A single primary study, even when well executed, has various limitations (Ioannidis, 2005); nevertheless, our results do indicate that differences in knowledge outcomes appear small, and the knowledge life span likely to be short. If any gain in knowledge exists, it might be easily lost. The implication is that changes in behaviours, a direct consequences of changes in knowledge, may be difficult to obtain or might not be attainable at all, at least when a single CME program is implemented for short time period (i.e. few months). In our study, the inconsistent effects of CME across knowledge outcomes may not be reflective of the intervention's genuine ineffectiveness, but deriving from the lack of compliance by health professionals to consistently implement the educational intervention. Given the variability in individual knowledge level outcomes and high attrition, the sample size may have been increased to consider the extra variability and scarce compliance in real everyday practice settings. The consequences are that the quantitative results of our trial should only be seen as suggestive, not conclusive. In broad terms, teaching EBM through a distant online format made up of vignettes, point-of-care services, and multiple choice questions does not result in major benefits for knowledge outcomes.

6.3 Key messages to the ‘CME community’

The results of this research program provide evidence to fuel the debate on the prospects of CME. Various scenarios for the future of CME have been proposed, according to which continuing medical education may: (1) be restricted or eventually abolished, at least as a mandatory recertification requirement (Hayes, 1995); (2) become more privatized and industry driven (Heckelman, 2009, Heckelman and Garofano, 2010); (3) become more driven by public and independent dictates (Pisacane, 2008, Gould, 2008); (4) acquire a more global outlook (Horsley et al., 2010); or (5) try to be as fully engaged with clinical practice as possible (Moja et al., 2007). For those proposing that CME be restricted, our results may be interpreted as evidence that limiting CME will not likely affect doctors' competences or behaviours, on average. For those proposing that CME be supported primarily by pharmaceutical companies, the future scenario will depend on public pressure and the acceptability of CME for modest gains in knowledge. If pressure decreases and it is evident that CME might be scarcely beneficial, health authorities and institutions might restrict the scope of CME to some neglected diseases or groups of health professionals that are not targeted by drug companies. The control of CME contents, programs, and events will eventually return entirely to pharmaceutical companies. However, many clinical contents that are not considered by drug companies to be of primary or economic interest will remain unaddressed. For instance, not-profitable relevant interventions such as rehabilitation or under-represented populations such as children, pregnant women, and the very elderly will be frequently excluded from drug company-sponsored CME contents and events such that they will receive a disproportionately limited amount of attention. For the other scenarios (i.e. CME is driven by public and independent dictates, acquires a global outlook, or is more fully engaged with clinical practice), however, our results can be more promising. They show that programs that provide information as opposed to those making clinical recommendations cover a wide range of diseases and interventions, are devoid of commercial biases, have strong endorsement from health authorities for the implementation of their information, and are well-received and adopted by health professionals (Formoso et al., 2003, Moja et al., 2007). The online educational techniques and formats related to point-of-care services will improve over the next years, creating the basis for better gains in health professional knowledge and competence.

6.4. Key messages to the knowledge translation field

The key message for researchers and policy makers involved in the knowledge translation field is that it is possible to conduct a high quality trial evaluating the efficacy of national CME initiative targeting general population of health professionals. Our trial was conducted with limited resources in an unfavourable political period culminating to the termination of the ECCE program (AIFA (Agenzia Italiana del Farmaco), Di Diodoro, 2008, Centro Studi e Ricerche in Medicina Generale (CSerMEG), 2008, Infermieri informatizzati, 2013, Centro Cochrane Italiano, 2008).

The presence and implications of ‘political’ attrition between the health authorities such as the Italian Medicines Agency and representatives of drug companies (i.e. Farindustria – the lobby of Pharmaceutical Research and Manufacturers of Italy) are difficult to be measured. Nevertheless, it might have influenced the conduct of the trial, the effect most likely to be negative. For instance, after applying the theory of planned behaviour, we were unable to further explore the correlation between gain in clinical competence and the change in intended behaviours (Ajzen, 2001, Ajzen, 2011) given the early termination of the research program. The direction and magnitude of these potential effects and whether they directly or indirectly impacted the trial results, however, cannot be fully elucidated. Because of the negative contingency of these effects, there is a need to replicate experiments similar to ECCE in a more favourable environment. These additional experiments are further needed because there remains uncertainty as to the true effects of online CME based on point-of-care information services.

A second recommendation concerning future research for CME based on evidence syntheses is to discern its specific characteristics that are associated with knowledge drop over time. If this intervention produces a small gain in knowledge across large populations of health professionals, the next efforts should be directed toward maintaining these small increases while preventing their quick loss. Strategies that maximise knowledge and behavioural gains and promote their retention over time will ensure, or at least protect, the efficient investment of educational resources.

6.5. Second birth with a global outlook

The positive elements of ECCE and this research program created the basis for its uptake at an international level. During the same year of ECCE’s termination in Italy (i.e. 2008), The Cochrane Collaboration manifested its interest to start a continuing medical education program based on Cochrane reviews and, consequently, performed an in-depth analysis of

the features of ECCE as a possible model for the development of its e-learning program. The Cochrane Collaboration is a unique, worldwide, and not-for-profit organization that was formed in 1993 and now includes over 30,000 active participants from more than 110 countries. The mission of the Cochrane Collaboration is *“to help people make well informed decisions about all forms of health care by preparing, maintaining and promoting the accessibility of systematic reviews of the effects of healthcare interventions”* (The Cochrane Collaboration). The Cochrane Collaboration: supports the synthesis of systematic reviews of the effects of healthcare interventions and policies and diagnostic test accuracy; builds capacity to conduct and use reviews amongst diverse stakeholders; develops the methods of systematic reviews; and conducts diverse knowledge translation activities with a broad range of partners. The intent of the Collaboration’s CME program was to develop a derivative product of Cochrane reviews, which extracts and reformulates relevant contents of reviews to better meet the needs of health professionals. In 2009, a pilot project – Dr Cochrane – was initiated to test the feasibility and appeal of Cochrane reviews as a source of educational material. Dr Cochrane adopted a framework similar to ECCE: clinical vignettes based on one or more Cochrane Reviews, which describe a clinical situation and ask questions answerable from the Cochrane Review. Central to both programs is the use of narratives to frame the learning modules in the effort to motivate practitioners to use established bodies of quantitative knowledge in clinical practice and to internalize the results and implications of current research. There were multiple methodological and technical challenges associated with this undertaking, particularly because Cochrane reviews are mostly developed by researchers for other researchers, address parcelled questions (e.g. efficacy and safety of a single intervention) instead giving a complete answer to clinical problems (e.g. multiple treatments overview), and are long documents in which the relevance of the clinical messages is diluted by the ‘overgrown’ methods and meta-analytical techniques (Pagliaro et al., 2010) (Wallace et al., 2012) (Greenhalgh, 2012).

Furthermore, the general experience in producing Cochrane vignettes has been that the extraction of relevant and applicable information for health professionals is not an easy process and is very time consuming. Despite these challenges, the initial Dr Cochrane pilot modules were finalized and published in the Evidence Based Child Health Journal (Moja, 2011 , Moja, 2010a, Moja, 2010). A partnership with Wiley Blackwell was subsequently developed, resulting in a pilot web based continuing educational professional development system hosted on a temporary Cochrane Learning platform to facilitate user access. The

pilot allowed us to test the idea of the program with potential funders and target audiences. In 2010, there were 672 registered participants on Dr Cochrane - Cochrane Learning (22% from North America, largely recruited through the Cochrane Journal Club and Cochrane Library issue alerts) who had access to five Dr Cochrane modules accredited by the European Paediatric Association. While the sample of users was somehow limited and the accreditation process was facilitated and informal, the feedback was largely positive with users expressing considerable enthusiasm for accessing such a tool if it could be brought to the market.

In 2011, the Canadian Institutes of Health Research awarded the Canadian Cochrane Centre a knowledge translation grant to work in partnership with the Italian Cochrane Centre to further develop the Dr Cochrane project, addressing, in particular, musculoskeletal and gastrointestinal conditions for Canadian doctors. Family physicians, specialists, and Cochrane Review Groups (Back, Musculoskeletal, Inflammatory Bowel Disease and Functional Bowel Disorders, and Upper Gastrointestinal and Pancreatic Diseases) selected the reviews according to their quality, relevance, and potential impact. Seventy modules have been produced to date by The Cochrane Collaborationⁱⁱ and The Cochrane Library publisher (Wiley-Blackwell) with support of the University of Ottawa Continuing Medical Education Office. The official Canadian Pilot of Dr Cochrane modules was launched in November 2013 in the Cochrane Learning platform (Canadian Cochrane Centre, 2013). These modules have been formally accredited by the Royal College of Physicians and Surgeons of Canada, the College of Family Physicians of Canada, and the US Accreditation Council for Continuing Medical Education (ACCME). In 2012, Dr Cochrane became one of the main themes of the strategic plan developed by The Cochrane Collaboration to prioritise recommendations relating to Cochrane Reviews and their derivative products to inform the direction of work for the next three to five years (MacLehose et al., 2012).

6.6. Significance of this research program

Science is a cumulative process that develops iteratively. Few studies, by themselves, are sufficiently persuasive to change practice, policy (i.e. editorial), or complete the process of bringing a new product to the market. The significance of the results of this Doctoral of Philosophy program should be placed in the context of the global development of CME,

ⁱⁱ In 2013 Lorenzo Moja has been appointed as Program Editor of the Dr Cochrane.

EBM, and editorial activities and products. Nevertheless, individual studies may contribute to understanding the feasibility, efficiency, and reliability of knowledge translation efforts and might be key in dispersing positive knowledge translation innovations across countries. This research program represents an additional step forward in the ongoing process of refining evidence synthesis and knowledge translation. The generalizability of these research results has yet to be demonstrated by fully testing them in other health care systems and markets. The practical utility of online CME programs based on high-quality syntheses of evidence in transferring knowledge and improving practice for health care professionals needs to be improved and refined. The particular characteristics underlying effective interventions, which best facilitates knowledge and practice gains, and the variations in their impact across persons and settings should be further explored through future investigations.

Postscript

The knowledge generated by this PhD contributed to the development of a new initiative of The Cochrane Collaboration, Dr Cochrane. Cochrane Reviews are high quality and statistically rigorous, but can be difficult to read from start to finish. Unless the evidence contained within Cochrane Reviews is translated into clinical practice, professional behaviour does not change and the knowledge gap between evidence and practice persists (Grimshaw, 2004).

Cochrane Learning addresses the knowledge-to-action gap by providing an innovative online educational environment in which health professionals can continue their professional development. All educational content is based upon high-quality systematic reviews produced by The Cochrane Collaboration. The most innovative programme within the new suite of educational tools available from Cochrane Learning is Dr Cochrane. Cochrane evidence is presented in a memorable fictional story, while corresponding multiple-choice questions provide users with the opportunity to explore and understand the clinical applicability of a Cochrane Review in a new way. Dr Cochrane transforms passive reading of a Cochrane Review into a more interactive learning experience to improve the understanding of Cochrane Reviews and change professional behaviour (Fox, 2000) (Hinyard and Kreuter, 2007) (Peabody et al., 2000).

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Appendix 1. Operational definitions adopted for this study

General characteristics of EBP point-of-care services (Table 3.1)

- Name
- Year of release
- Vendor/Publisher: institutions, editors, company providing and publishing resources.
- (Marketing) claim: as stated directly in the website homepage or “About us” section.
- Fee based/Open access: if a paid subscription fee is required to access the whole content of the resource.
- Type of subscription: single user, institutional, “à la carte”, pay per view, etc.
- Format: description of the different product formats (i.e. online, desktop, PDA, etc.)
- Annual cost: for a single-user subscription per year.
- Target: to whom the information tool is mainly addressed (general practitioners, specialty physicians, etc.). We also reported if it is stated that other health care professionals can benefit from that information tool contents.

Content presentation of EBP point-of-care services (Table 3.2)

- Output presentation
 - Type of output: book chapter-like summaries, key point summaries, answers to clinical questions, other.
Formal ontology of information: extent to which the tool is optimised to provide consistent and schematic information (through domains – e.g. drugs, and classes – e.g. antibiotic) that can be easily accessed during a consultation. Other examples of domains and classes are: benefit/overall survival; harm/ neurotoxicity; complementary medicine / acupuncture.
(yes/no) (De Bruijn and Martin, 2002) (Shahar et al., 2004)
 - Summary flexibility: ability to retrieve brief relevant information and in-depth content by opening or expanding a single section or category. (yes/no)

- References/link to bibliography: if general references suggested to deepen particular topics, or references supporting any reported statements are included. (Yes specific/Yes, general/No)
- Intent to recommend: extent to which the summary gives clinical guidance to direct action as well as providing research results (from facts to acts). (yes/no)
- Strength of recommendation formal grading: the use of a formal system to grade the strength of recommendations. (yes/no) (Atkins et al., 2004b)
- Education programme
 - Continuing medical education (CME) programmes: link to CME systems with the possibility of collecting CME credits. (yes/no)
 - Additional education materials: e.g. statistical and methodological supporting material. (yes/no)
- Patients handout: a plain language content specifically developed for patients and hosted by the website (outer links were excluded). (yes/no)

Editorial quality (Table 3.3)

- Authorship: clear indication of the author(s) of a specific content reported in the output. A generic “editorial team” was considered unclear.
- Reviewing process: a detailed description of the procedures aimed at assessing and ensuring the scientific quality of output (review process by external peer reviewers and/or by editors). (Jefferson et al., 2007)
- Updating: frequency of content updating (continuously, periodically, once a year, etc). Content updated within two years was considered adequate as a sign for updating occurred within two years for 23% of reviews (Shojania et al., 2007).
- Authors’ conflict of interests: whether a formal policy on authors’ commercial conflict of interests is implemented and this information is reported (Boyd and Bero, 2006) (Krimsky and Rothenberg, 1998).
- Commercial support: to what extent commercial support and advertising are accepted in the content development policy (Krimsky and Rothenberg, 1998) (Smith, 2005). (Krimsky and Rothenberg, 1998, Smith, 2005)

Evidence-based Methodology (Table 3.4)

- Literature search/surveillance: indication of whether contents are written on the basis of a specific systematic literature search based on explicit search strategies and aimed at identifying relevant and valid articles or if systematic tracking of the relevant and valid articles based on predefined sample of leading journal and journal review services is utilised (Lefebvre et al., 2008).
- Cumulative vs. discretionary approach: whether content is preferably written on the basis of systematic reviews, particularly Cochrane Reviews rather than other publications (McKinlay et al., 2008).
- Critical appraisal methodology: the use of standard and transparent methods to assess articles' validity (Higgins and Altman, 2008).
- Grading of evidence quality: if a formal system is implemented to grade the level of evidence (Atkins et al., 2004b).
- Cite expert opinions: if statements based on experts' opinions are easily recognisable compared to study data and results (Antman et al., 1992).

Appendix 2. Instrument to measure editorial policy quality (max 15 points)

1. Is/Are the content author(s) clearly stated?
Score: 3 for "clearly stated", 1 for "unclear", and 0 for "not stated"
2. Has peer reviewing been done?
Score: 3 for "done", 1 for "unclear", 0 for "not done"
3. Is content updating adequate (within two years)?
Score: 3 for "yes", 1 for "unclear", 0 for "no"
4. Is a formal policy implemented and reported on authors' commercial conflict of interests?
Score: 3 for "yes, implemented and reported", 1 for "implemented but not reported", 0 for "conflict of interests not requested (no information)"
5. Does the website accept any type of commercial support?
Score: 3 for "not accepted", 1 for "accepted but disclosed", 0 for "no information"

Appendix 3. Instrument to measure EB methodology (max 15 points)

1. Is a systematic literature search or surveillance the basis of content development?
Score: 3 for "yes", 1 for "unclear", and 0 for "no"
2. Is the critical appraisal method fully described?
Score: 3 for "yes", 1 for "unclear", 0 for "no"

3. Are systematic reviews preferred over other types of publication?
Score: 3 for “yes”, 1 for “unclear”, 0 for “no”
4. Is there a system for grading the quality of evidence?
Score: 3 for “yes”, 1 for “unclear”, 0 for “no”
5. When expert opinion is included is it easily recognisable over studies’ data and results?
Score: 3 for “yes”, 1 for “unclear”, 0 for “no”

Appendix 4. Online EBP information resources excluded and reasons

EBP Information Resource	Reason for exclusion
ATTRACT	Not periodically updated
TRIP	Search engine
STAT! Ref	Meta-list
Evidence-Based Medicine Reviews (EBMR)	Meta-list
Essential Evidence Plus	Meta-list
EBM Search engine	Search engine
The Cochrane Library	Secondary literature
Clinical Information Access Program (CIAP)	Meta-list

CLIN-eGUIDE	Meta-list
Evidence Matters	Search engine
MedLine Plus	Meta-list
AccessMedicine	Meta-list

Appendix 5. EBP point of care summary scores and ranks according to coverage, editorial quality, and EB methodology

Name	Coverage		Editorial quality		EB Methodology	
	%	Rank	Score	Rank	Score	Rank
5-minutes consults	83.7	5.5	4	14.5	0	16
ACP Pier	75.5	10.5	9	7	10	8.5
BestBets	53.1	14.5	6	11	15	2.5
CKS	53.1	14.5	6	11	10	8.5
Clinical Evidence	67.3	13	15	1.5	15	2.5
Dynamed	87.8	2	11	4	12	5.5
EBM Guidelines	85.7	4	9	7	15	2.5
EMedicine	87.8	2	13	3	1	13
eTG	44.9	16	10	5	1	13
First Consult	87.8	2	7	9	1	13
GP Notebook	83.7	5.5	4	14.5	1	13
Harrison's Practice	79.6	9	3	16	1	13
Map Of Medicine	69.4	12	6	11	12	5.5

Micromedex	75.5	10.5	5	13	11	7
Pepid	81.6	7.5	9	7	2	10
UpToDate	81.6	7.5	15	1.5	15	2.5

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